



A MANUAL OF SURGERY  
For Students and Practitioners



*First Edition, May, 1898*  
*Second Edition, September 1899*  
*Third Edition, September, 1900*  
*Fourth Edition, September, 1901*  
*Fifth Edition, August, 1902    Reprinted,*  
*September 1904*

# MANUAL OF SURGERY

For Students and Practitioners

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AND TO THE UNIVERSITIES OF LIVERPOOL AND LEEDS, ETC

SIXTH EDITION,

UNIVERSITY



SERIES

LONDON  
BAILLIERE, TINDALL AND COX  
8, HENRIETTA STREET, COVENT GARDEN

1905

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TO

LORD LISTER, LL D, F R S,  
*President of the Royal Society,*

THE FATHER OF ANTISEPTIC SURGERY,  
THIS WORK IS, WITH PERMISSION,

*Dedicated by the Authors,*

IN GRATEFUL ACKNOWLEDGMENT OF THE MANY ADVANTAGES  
THEY HAVE DERIVED

WHILST ASSOCIATED WITH HIM IN HIS WORK  
AT KING'S COLLEGE HOSPITAL



## PREFACE TO SIXTH EDITION.

INCREASING demands upon the time of my colleague, Professor Rose, have necessitated that I should take over the responsibility for issuing the sixth edition of this book. Professor Rose has made sundry suggestions and provided the material for several new pictures, and these I gratefully acknowledge. Certain modifications in the 'make-up' of the work (including a slightly wider page) have given an opportunity for more extensive modifications and alterations than have been effected since the original issue. Much new material has been introduced, old matter has been eliminated or modified, and several sections have been entirely recast. In order to ensure that the pathological side was accurate and up-to-date, the help of Dr W. D'Este Emery, clinical pathologist to King's College Hospital, has been obtained, and he has rewritten the opening chapter on 'Bacteriology,' added a new chapter on 'The Blood in Health and Disease,' and has carefully overlooked the whole work from a pathological standpoint. The elaboration of radiography both as a diagnostic and also as a therapeutic agent has necessitated a considerable modification in the sections dealing with the treatment of lupus and rodent ulcer, and we have to thank Mr A. D. Reid, radiographer to King's College Hospital, for help in this direction, as also for providing us with details as to the diagnosis of renal calculi. A fresh chapter has been devoted to modern surgical technique, the section on the head and brain has been rearranged, abdominal surgery is more efficiently represented, and a chapter added dealing with the surgical aspects of gynæcology. It will therefore not be surprising that the book has increased in size, although a change in the character of the paper has diminished its bulk, moreover, the inclusion of the plates in the text is largely

PREFACE TO SIXTH EDITION

responsible for the increased number of pages. The illustrations have been carefully revised, numbers of old blocks have been removed, and the new ones substituted will, it is hoped, prove acceptable. In this direction we must thank Mr S A Sewell for his willing and intelligent co-operation. The arduous task of revising the Index has again been undertaken by Mr T P Legg, Senior Surgical Registrar to King's College Hospital.

Finally, hearty thanks must be accorded to our publishers for their unfailing courtesy and for many valuable suggestions during the passage of the book through the press.

ALBERT CARLESS

*August 1905*

## PREFACE TO FIRST EDITION

IN preparing this Manual of Surgery for the profession, we have endeavoured to meet what we think is at the present time a genuine need. The many large and valuable text-books and works of reference already in existence are almost more than the ordinary student can master during the time at his disposal. It has therefore been our aim to present the facts of surgical science in a concise and succinct form, so as to satisfy the needs of the student, even of those who are preparing for the higher examinations. At the same time, the requirements of the general practitioner have not been overlooked, for we have taken care to discuss in detail those conditions which are most likely to be met with in ordinary practice. The main difficulty has been to compress into a small space the ever-increasing amount of material available, so that we have only been able to sketch in outline much that could have been elaborately described did the size of the book permit. For the same reason, historical and bibliographical references have to a large extent been omitted, whilst diseases of special regions—such as the eye, ear, and female genital organs—are also practically excluded, except in so far as they encroach on the domains of general surgery. The progress of bacteriology and the influence of antiseptics have so transformed the characters and extended the scope of surgical work, that many of the traditions and theories of the past have had to be discarded, although at the same time we have endeavoured to preserve and respect that which has been shown to be good and useful in the laborious researches and accumulated experiences of bygone generations.

In conclusion, our best thanks are due to Dr St Clair Thomson, who has kindly looked through the proofs of the sections devoted to



the nose and ear , to Dr Silk, who has fulfilled a similar office in reference to the chapter on anæsthetics , to Mr William Turner for preparing the Index , and to Dr Arthur Griffiths, late of the Bristol General Hospital, who has drawn several of the pictures, and given other valuable assistance

Many of the illustrations have been specially prepared for this work, but we have also to acknowledge the loan of blocks from Messrs Veit and Co , of Leipzig , from Messrs Cassell and Co , J and A Churchill, Longmans and Co , and from the editors of the *Lancet* for the loan of Fig 287 [296] The various sources from which these are derived are acknowledged throughout the book Illustrations of instruments are mainly derived from Messrs Down Brothers, who have kindly placed them at our disposal

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May 1, 1898

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# PLATE I

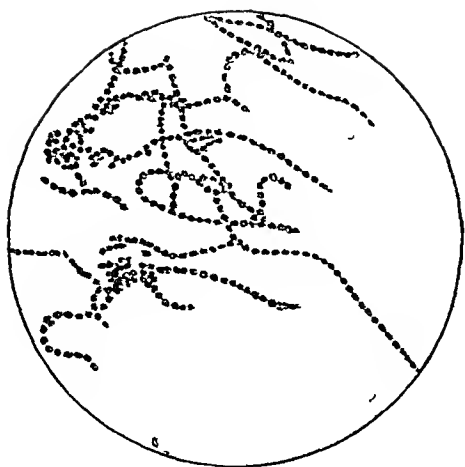


FIG 1

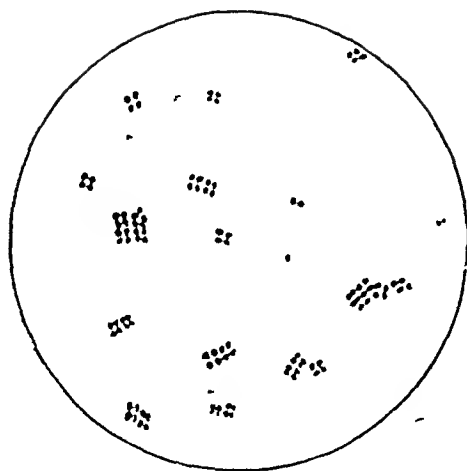


FIG 2

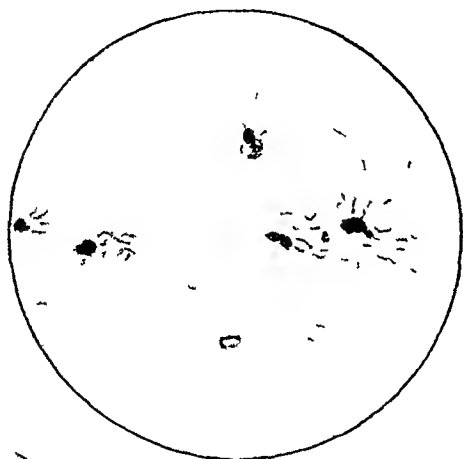


FIG 3

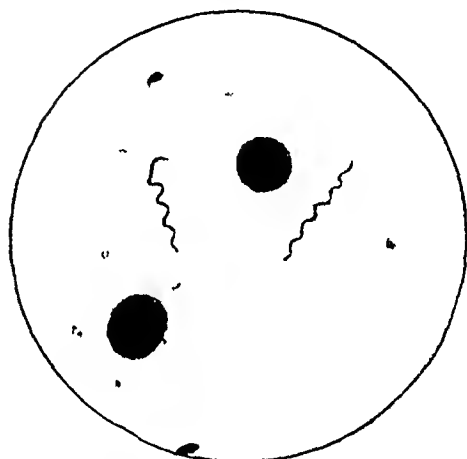


FIG 4

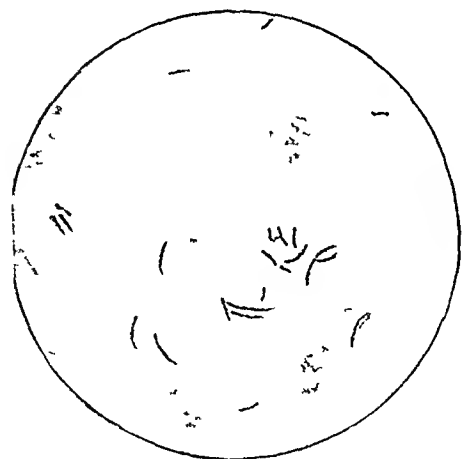


FIG 5



FIG 6

Fig 1 *Streptococcus pyogenes*

Fig 2 *Sarcina ventriculi*

Fig 3 *Bacillus typhosus* with flagella

Fig 4 *Spirillum Obermeieri* of relapsing fever

Fig 5 *Bacillus tuberculosis* (from sputum)

Fig 6 Gonococci in pus

# A MANUAL OF SURGERY

## CHAPTER I

### BACTERIOLOGY—INFECTION—IMMUNITY

THE importance to the surgeon of a study of bacteriology is twofold. In the first place, many surgical diseases (especially those of an inflammatory nature) are due to the action of bacteria, secondly, these organisms are practically ubiquitous, and in the absence of suitable precautions will infallibly enter any external wound, whether accidental or intentional, and by their development delay the process of healing, or even give rise to fatal results. Thus it becomes necessary for every surgeon to have a general knowledge of the habits and distribution of the more important species of bacteria, their mode of life, and the mechanism by which they give rise to morbid processes in the human body, as well as of the methods used in their investigation. It was only by means of such knowledge that the foundations of the present methods of treating wounds were laid, and without it it is difficult to apply these methods intelligently in actual practice. In addition, the diagnosis of disease is often much assisted by the bacteriological examination of morbid products, and although the methods employed are in many cases extremely simple, yet they frequently lead to information of the highest importance in diagnosis and prognosis.

Bacteria (schizomycetes, or fission fungi) form a very important group of the lower plants. Although several thousand species have been described, comparatively few are of importance in medicine or surgery. They may be defined as very minute unicellular plants, which reproduce themselves by simple fission, or in some forms by endogenous spore-formation, not more than one spore being formed in each cell. They are devoid of organs except flagella, and they contain no chlorophyll. Their structure is extremely simple. They consist of a delicate cell-wall (composed of cellulose or an allied substance), which encloses a mass of protoplasm, in which there may be one or more vacuoles and a few granules of unknown nature. External to the cell-wall there is sometimes a gelatinous capsule,

which may serve to unite the bacterial cell loosely with its neighbours. When such capsules become very prominent, large numbers of bacteria may become embedded in a gelatinous mass, known as a *zooglaea*. Capsule formation is of some importance in diagnosis, the pneumococcus, for example, possesses a well-marked capsule when it occurs in blood or morbid exudates, and may thereby be distinguished from many organisms otherwise resembling it.

The **Methods of Reproduction** which occur among the bacteria are extremely simple, nothing akin to sexual processes having been observed. In *simple fission* the cell becomes divided into two by a thin membrane, and these two portions develop into mature organisms. In many cases the two bacteria thus produced become entirely separated from one another, but in some species they remain more or less connected by means of the capsules described above, and in this way the individual bacteria become united into groups, which are more or less characteristic of the species. This process of division may take place with great rapidity, so that a suitable material which has become infected with one or two bacteria may contain vast numbers in the course of a few hours.

*Spore-formation* is a more complicated process, and is found only in certain of the rod-shaped bacteria or bacilli. Bacterial spores are round or oval in shape, and are formed within the bacterial cell (endospores). They consist of a thick cell-wall filled with protoplasm, which contains less water than the mature bacterium, and has, therefore, a highly refractile appearance when seen under the microscope. The shape and size of the spores have much diagnostic value, thus, the bacillus of tetanus has an almost spherical spore, which is distinctly larger than the diameter of the rod in which it is formed, whilst the spore of the anthrax bacillus is oval, and little or no broader than the rod itself. The position of the spore is also of importance. The spores of the tetanus bacillus are at the extreme end of the bacillus, giving it the appearance of a drumstick, whilst those of anthrax are central. Spores are to be regarded as resting forms adapted to maintain the life of the species under adverse conditions, and in this respect are analogous to the seeds of the higher plants. They resist drying to a far greater extent than do the bacteria themselves. Anthrax spores have been preserved in the laboratory for twenty years without loss of viability or virulence, whilst asporogenous anthrax dies in a few weeks when dried. They are also very resistant to heat. Most bacteria (when moist) are killed when exposed to a temperature of  $60^{\circ}\text{C}$  for half an hour, whereas many spores are not killed by prolonged boiling. Lastly, they are very difficult to kill by means of antiseptics. Anthrax spores can be killed by immersion in 1 in 20 carbolic lotion, but only after several days. Of the bacilli of chief interest to the surgeon the *B. tetani*, *B. anthracis*, *B. oedematis maligni* form spores, whilst those of glanders, tubercle, diphtheria, typhoid fever, leprosy, influenza, and soft sore are asporogenous.

Flagella are delicate filamentous extensions of the protoplasm,

which occur in those bacteria which are possessed of spontaneous mobility. They are sometimes of great length, but are always extremely thin, and are only visible after the use of complicated staining processes. Their number is of importance in diagnosis. The typhoid bacillus, for example, has usually from twelve to twenty flagella (Plate I, Fig 3), whilst the closely-allied *B coli* has from three to six. It should be remembered that bacteria which are devoid of flagella often exhibit very marked Brownian movement, which the uninitiated might mistake for spontaneous motility.

The **Classification** of the bacteria is based, in the first instance, on their morphology, but owing to the simplicity of the shape of the organisms, morphological characteristics have to be supplemented by physiological and cultural properties in the definition of the separate species. There are three great groups—the cocci, bacilli, and spirilla.

I **Cocci** are organisms which are spherical, or nearly spherical. They constitute the simplest forms of bacteria, since but few species possess flagella, and spore-formation is unknown. They are subdivided according to the methods in which the individual cocci are arranged. (a) *Micrococci* are those forms in which there is no definite arrangement into groups. The term 'staphylococcus'—more properly the name of a species, the *Staphylococcus pyogenes*—is applied to cocci in which the individual elements are arranged in clusters resembling bunches of grapes (Fig 3, p 54). (b) *Diplococci* (Plate I, Fig 6) are forms in which the two elements arising from the division of a single coccus remain in more or less close apposition, so that they are arranged in pairs. (c) *Streptococci* (Plate I, Fig 1) are arranged in longer or shorter chains, like a necklace. This formation is due to the fact that the successive planes of division by which the cocci are divided lie parallel to one another. (d) In a few cases a coccus divides into two, which are again divided by a plane at right angles to the first, so that the four cocci which result lie at the corners of a square, these are called *Tetrads*. Lastly, (e) *Sarcinae* are formed by three consecutive divisions in the three planes of space, so that the eight cocci which are formed lie at the corners of a sphere (Plate I, Fig 2). In these forms the separation of the individual cocci is rarely complete, so that the mass resembles a bale of wool tightly tied in three directions. These cocci often divide again, and lead to the formation of composite masses.

II **Bacilli** (Plate I, Fig 5) are bacteria which have the form of rods, the long diameter of the cell being greatly larger than the short diameter. They are usually straight, but, if curved, the curve is only in one plane, so that the rod would lie flat on a plane surface. Spore-formation is common in this group, and many of its members possess flagella. The group is not subdivided, but the terms *streptobacillus* for those which remain adherent in chains, and *leptothrix* for forms which produce long threads before breaking up into short rods, are convenient.

III **Spirilla** are rods which are uniformly curved in the three



planes of space, so that when sufficiently long they form corkscrew-like spirals. Short forms also occur, and these are sometimes designated *vibrios*, the term 'spirilla' being then reserved for the long spiral forms. The spirilla are not of much surgical importance, the only well-known pathogenic varieties being the *V. cholera Asiatica* and the spirillum of relapsing fever (Plate I, Fig 4).

In regard to their physiology, bacteria resemble the other plants devoid of chlorophyll in being unable to form proteid from simple materials in presence of sunlight, and have to be supplied with ready-formed organic nitrogen from animal or vegetable sources. Regarded from this standpoint, they may be divided into two classes—the *parasites*, which can obtain their pabulum only from the living animal (or plant), and the *saprophytes*, which are unable to do so, and flourish only in dead materials. The leprosy bacillus may be taken as an example of a strict parasite, since, as far as is known at present, it grows only in the living tissues, and cannot be cultivated outside the body. The term *facultative saprophyte* is applied to those organisms which prefer a parasitic existence, but which will grow under suitable conditions in dead materials. The gonococcus is a good example, it multiplies readily enough in the living mucous membrane, but grows only feebly on dead culture media. *Facultative parasites*, on the other hand, are organisms which grow best in dead materials, but which have the power of adapting themselves to a parasitic existence. It must be understood that the terms 'parasitic' and 'pathogenic' are not quite synonymous. A *pathogenic* organism is one that has the power of producing disease, and it may do so without entering the living tissues at all, as when putrefactive organisms gain access to a blood-clot in the uterus and cause sapræmia. A parasitic organism is not necessarily pathogenic, especially in the lower animals, since these frequently harbour blood-parasites without appearing to suffer therefrom in any way.

In addition to combined nitrogen, all bacteria require water, certain salts, and a suitable temperature for their growth. The necessity for water must be borne in mind in surgical practice, and every attempt must be made (by accurate co-aptation of parts, drainage, etc.) to prevent the accumulation of putrescible material in wounds or body-cavities. This is well seen in dealing with the peritoneum, the absorptive power of which is one of the chief natural defences against peritonitis. In laboratory experiments we find that large amounts of fluid cultures of pathogenic bacteria can be injected into the peritoneal cavity of animals without injury, the fluid is rapidly absorbed and bacterial growth ceases. If, however, the peritoneum is injured so that absorption is checked, the bacteria continue to grow, and fatal peritonitis results.

The requirements of different bacteria as to temperature vary enormously. The majority of those of importance in human pathology grow best at or about the body temperature (37° C), but many forms, especially those which are commonly met with as saprophytes outside the body (such as *Staphylococcus pyogenes* and *B. coli*), grow

well at 18° C, or even lower. Other forms flourish best at lower or higher temperatures than these, but they are not of pathological importance. Lower temperatures inhibit growth, but do not kill the bacteria unless applied for long periods. The destruction of bacteria and spores by heat has been already mentioned.

Light is injurious to almost all bacteria. This is especially the case with *B. tuberculosis*, which *in vitro* is killed after a very short exposure to sunlight and more slowly by diffused daylight. The action seems to depend on the formation of peroxide of hydrogen in the culture medium.

Many pathogenic organisms require free oxygen for their development, and are spoken of as *aerobes*. A few, such as the tetanus bacillus, will grow only in the complete absence of oxygen, ceasing to develop, though still remaining alive, when that gas is admitted; such organisms are called *anaerobes*. Bacteria which grow best in air, but which will also grow in its absence, are called *facultative anaerobes*, and those which grow best under anaerobic conditions, but are capable of some growth in presence of oxygen, are called *facultative aerobes*. It must be pointed out that the conditions in the living body are peculiar, in that both strict aerobes and strict anaerobes are capable of growth. Further, a strict anaerobe may grow in a fluid freely exposed to air in the presence of other organisms which have a great affinity for oxygen and rapidly absorb it. In this way tetanus bacilli may flourish in superficial wounds freely open to the air if other bacteria are present.

In their growth bacteria give off metabolic products which are often of great importance. The chief of these are (1) acids, such as lactic, acetic, butyric, etc., (2) alkalies, (3) gases, such as sulphuretted hydrogen, marsh gas, etc., (4) pigments, such as the green colouring matter produced by *B. pyocyaneus* and seen in the so-called blue pus, (5) aromatic substances, such as indol, phenol, and tyrosin, (6) alcohol and other similar bodies, (7) ferments—*e.g.*, diastase, invertase, and a ferment allied to rennin. A more important enzyme is one resembling trypsin and having the power of peptonizing proteid material. This is produced by one of the commonest pus-producing organisms (*Staphylococcus pyogenes*), and plays some part in the destruction of the tissues in suppuration. The presence or absence of this ferment is usually ascertained by cultivating the organism in question on gelatin or coagulated blood-serum, either of which is digested or 'liquefied' if the enzyme is produced. (8) Certain crystallizable organic substances of definite chemical composition, allied to the vegetable alkaloids, and spoken of as *ptomaines*. They have some poisonous properties, and were once thought to be of great importance in the production of disease. (9) The true toxins have never been isolated in a state of purity, but appear to be allied in chemical composition to the albumoses, and have some features in common with the enzymes. They are intensely poisonous when injected into the blood or tissues, though innocuous (in most cases) when taken by the mouth. They are very unstable substances, being readily

destroyed by heat, peptic digestion, etc., and when kept in a state of solution gradually become inert

Toxins are divided into two distinct classes (a) Certain organisms, of which the most important are the bacilli of tetanus and diphtheria, produce soluble *extracellular* toxins which accumulate in the fluid in which they are grown (b) In the case of many other organisms, all attempts to produce a powerful soluble toxin have failed, and the specific poison appears to remain locked up in the bodies of the bacteria, and is only given off under conditions which we are unable to reproduce experimentally These are known as *intracellular* toxins For example, the soluble products secreted by the tubercle bacillus have but little toxic action, whereas the washed bodies of the bacilli themselves are extremely poisonous

The pathological effects of these toxins are highly diverse, but in nearly all cases they include the production of fever Some are selective in their action, affecting only a certain class of cell—e.g., the cells of the central nervous system in the case of tetanus Others, such as those of the pyogenic bacteria, affect any tissues they may happen to reach Under natural conditions the results of their presence in the body vary according to the amount of toxin produced, and to the susceptibility of the animal and of the tissues in question Thus a very powerful toxin may immediately destroy the vitality of a part, leading to gangrene, whilst one that is somewhat less intense in its action may kill the tissues *en masse*, but only after leading to an acute inflammation, thereby inducing one form of coagulation-necrosis A similar but still slower process leads to caseation, in this fatty degeneration has time to supervene in the affected tissues before their death In another group of cases the acute inflammation may terminate in a slower but progressive molecular death of the tissues, a cell at a time, leading to suppuration Finally, if a very feeble toxin acts for prolonged periods it may serve as a stimulant to growth and lead to proliferation of the fibrous tissues, etc., without the development of any external signs of inflammation

**Distribution**—Bacteria are very widely distributed in nature Their presence in the air varies greatly with circumstances They are absent from the pure air of mountain-tops or the mid-ocean, and present in vast numbers in cities, especially in houses They are not given off from the surface of liquids containing them, and only remain in suspension in the atmosphere when adherent to particles of dust or moisture They are more plentiful in dry weather than in wet, and more abundant in occupied houses than in the open air When the atmosphere of an enclosed space is kept at rest, the dust gradually sinks to the bottom and the air becomes absolutely sterile It has been found that the air of schoolrooms contains far fewer bacteria when the scholars are sitting quietly than when they are allowed to move about—a fact which should be borne in mind by the spectators at a surgical operation Expired air is sterile, but in speaking and coughing vast numbers of minute particles of fluid are ejected, and

these are charged with bacteria, and may remain suspended in the air for long periods. This is of special importance in surgery, since the bacteria thus given off from the mouth are frequently pathogenic, and may constitute a source of danger in operations. The bacterial contents of *water* also vary greatly. That suitable for a public water-supply should contain but few bacteria, and pathogenic forms should be absent. Where this is known to be the case, the water may be used in an emergency to cleanse wounds, though even then it is desirable to sterilize it by heat or filtration, but in the great majority of samples of water from natural sources the probability of the presence of injurious bacteria is so great that a preliminary sterilization is absolutely necessary before their use for surgical purposes. *Earth* contains vast numbers of bacteria, and pathogenic varieties are frequently present.

The human skin teems with bacteria, like anything else which is exposed to dust and dirt. The majority of these organisms are present simply by accident, and are readily removed by washing. A few, however, are normal inhabitants of the skin, and are very difficult to destroy, as they penetrate deeply. Bacteria are also present in the alimentary canal from the mouth to the anus, the external auditory meatus, the inferior meatus of the nose, the conjunctiva, the anterior portion of the male urethra, and the lower portion of the virgin vagina. The superior meatus of the nose, the deeper portions of the urethra, and the upper part of the virgin vagina are in general sterile, as are also the gall-bladder, together with the biliary and pancreatic ducts. The blood and deeper tissues of a healthy animal are usually free from germs, but careful observations have shown that the escape of small numbers of bacteria from the alimentary canal into the blood and lymph is a common, perhaps constant, occurrence. Under conditions of health these bacteria do not find suitable conditions for continued growth in the body, and are soon destroyed, but when the general vitality of the body is lowered, or when a lesion is present, these bacteria may find a suitable foothold, continue to grow, and give rise to pathological effects. This is probably the explanation of the suppuration that sometimes occurs in deep lesions, such as the subcutaneous rupture of a muscle or ligament, and it is termed *auto-infection*.

**Methods of Observation** —(1) *Microscopical Examination* — This may be carried out on morbid material taken direct from the body, or on cultures of organisms derived therefrom. A high magnifying power and a suitable substage condenser are necessary. The material may be stained or unstained. Unstained specimens are usually examined in a 'hanging-drop' preparation, and this enables the observer to recognise the shape, size, and arrangement of the bacteria present, the presence or absence of spores, and also whether the organism is motile. This method of examination is of the highest importance in dealing with cultures, and should never be omitted. For morbid exudates, pus, etc., it is often unnecessary, and chief reliance is placed on stained specimens. To this end a thin film

of the material is spread on a clean slide or cover-glass, allowed to dry, and fixed by being passed two or three times through the flame. This film is then submitted to the staining process, of which there are three chief varieties.

(a) *Simple stains*, such as carbol fuchsin, carbol-thionin, methylene blue, etc., affect all bacteria, as well as the cells, nuclei, etc., of the morbid material. They enable the presence of the bacteria to be recognised, and their shape, size, etc., to be determined. The other two methods are differential stains, and of great importance in the recognition of the species of bacteria present.

(b) *Gram's Method* — The film is immersed for three to five minutes in a stain consisting of 10 parts of a saturated alcoholic solution of gentian violet diluted with 90 parts of 1 in 20 carbolic acid in water. It is then treated for two or three minutes with a watery solution of iodine in iodide of potassium (iodine 1, KI 2, water 300), and finally washed in alcohol until no more colour is dissolved out. Some bacteria remain stained when treated in this way, whilst others are completely decolorized.

The following are stained: Staphylococci, *Streptococcus pyogenes*, the pneumococcus, the *Micrococcus tetragenes*, the bacilli of tetanus, anthrax, tubercle, leprosy, diphtheria, and the streptothrices causing actinomycosis.

The following are unstained: The gonococcus, the meningococcus, the *Micrococcus Melitensis*, the *B. coli*, the bacilli of glanders, typhoid fever, influenza, and soft sore, the *B. pyocyaneus*, the vibrio of cholera, and the spirillum of relapsing fever.

(c) *The Ziehl-Nielsen Method* — The film is stained by means of a powerful stain, usually carbol fuchsin, which is either heated or allowed to act for several hours. It is then immersed in 20 to 25 per cent sulphuric acid for five or ten minutes. This removes the stain from all cells, etc., and from the majority of bacteria. A few, however, retain it, and these are called *acid-fast*. Films may also be stained in the same way and subsequently decolorized in alcohol, and organisms which retain the stain are called *alcohol-fast*. Of the organisms which are of importance in human pathology, the bacilli of tubercle and leprosy and a bacillus frequently found in smegma are acid-fast, and the two former are also alcohol-fast. Certain streptothrices are also acid-fast.

(2) It is usually necessary to supplement microscopical examination by *cultural methods* in which a suitable culture medium is inoculated with the material to be examined and kept at a proper heat for the development of the bacteria suspected to be present. These culture media are very numerous, but broth, gelatin, solidified blood-serum, and agar agar suffice for most purposes. Broth consists of a solution of the extractives of meat, peptone, and salt. It is chiefly used for making cultures for animal inoculations, and for observations on the chemical products of bacteria. Solid culture media are more useful, since many organisms form characteristic growths or colonies on the surface or in the depth of the medium.

Nutrient gelatin is simply broth solidified by the addition of 10 to 15 per cent of gelatin, and is especially valuable, since it is liquefied by some bacteria, whilst others have no such action. A disadvantage is that it melts at the temperature necessary for the growth of many pathogenic bacteria, and when this is the case observations on the formation of a peptonizing ferment have to be carried out by cultures on blood-serum coagulated by heat. Agar-agar is broth solidified by the addition of a substance prepared from a seaweed. It is not melted at the temperature of the body, and is not liquefied by any organism. It is the most generally useful of all media for pathological work.

For the methods used in obtaining pure cultures of organisms from material containing a mixture of several varieties (often a matter of great difficulty) a work on bacteriology must be consulted.

(3) The *inoculation of living animals* is also frequently necessary. This method of investigation is, perhaps, most useful in the examination of morbid materials (urine, pus, etc.) for the tubercle bacillus, which is often present in such scanty numbers that it eludes a careful search, and cultural methods are hardly applicable in practice. The subcutaneous or intraperitoneal inoculation of a guinea-pig is an extremely delicate test, and will infallibly lead to the development of tuberculosis if living bacilli are present. The chief drawback is the fact that it takes two or three weeks for the disease to develop. Inoculations of pure cultures are often resorted to where the organism present has so close a resemblance to a non-pathogenic form that its recognition is a matter of uncertainty. Thus, several harmless organisms have a close resemblance to the anthrax bacillus, and the latter can only be distinguished by causing anthrax when injected into the lower animals. A refinement on this method, which is applicable in some cases, consists in injecting a normal animal and also an animal immunized against the organism suspected to be present in the culture. As an example, we may take the recognition of the tetanus bacillus in pus, where it is usually mixed with many other bacteria, so that it is excessively difficult to isolate. A broth culture is inoculated with the pus in question, and incubated in the absence of air, since the tetanus bacillus is an anaerobe. It is then divided into two parts, of which one is injected into a normal animal and the other into one which has received a dose of antitetanic serum. If the former dies and the latter remains alive, the presence of the tetanus bacillus in the culture is certain.

Injections are also necessary in order to prove that an organism which has been isolated in cases of a given disease is actually the cause of that disease. In the early days of bacteriology, when the bacterial origin of disease was hotly contested, Koch formulated the following postulates, and when these are fulfilled, we may consider the cause of the disease as proved to demonstration.

(a) The organism (which must be one that can be definitely recognised from all others) must be present in the body in every case of the disease.

(b) It must be possible to cultivate it for many generations apart from the body. This is to get rid of every trace of the substance taken from the first case of the disease in making the original culture.

(c) The inoculation of a suitable animal must be followed by the appearance of the specific disease.

(d) The organism must be found in the animal thus infected.

We do not now demand so rigid a proof of the pathogenic effects of bacteria. Thus, although the *B. lepro* is universally admitted to be the cause of leprosy, yet it has never been cultivated, so that only the first of Koch's postulates holds. Other tests, which space forbids us to describe, such as the presence of specific agglutinins in the blood of cases of the natural disease, are now applicable.

A few other micro-organisms other than bacteria require brief mention, but they are of little surgical importance.

1. The yeasts or *blastomycetes* are devoid of chlorophyll, and multiply by budding, or endogenous spore-formation, in which several spores are formed in each cell. They cause many forms of fermentation—e.g., the alcoholic fermentation in solutions of grape-sugar, they occasionally gain access to the urinary bladder in diabetes and, by leading to the production of irritative products of fermentation, give rise to cystitis. The hypothetical cancer parasite was regarded by some as belonging to this class, but this idea is now generally abandoned, and the only important disease attributed to the yeast-fungi is blastomycetic dermatitis. It is characterized by multiple lesions, resembling verrucous tuberculides or in some cases epitheliomata. It is extremely chronic, and good results have followed the administration of iodide of potassium.

2. The *hyphomycetes*, or filamentous fungi, are characterized by the presence of a mycelial network of long fibres, and have a method of sporulation which is more complicated than that seen in the bacteria or yeasts. The following are the more important of their pathological effects.

*Thrush*, due to *Oidium albicans*, an organism sometimes included in the blastomycetes, and called *Saccharomyces* or *Monilia albicans*.

*Ringworm*, which may be caused by *Microsporon Audouini* (the small-spored fungus), or the *Trichophyton* or large-spored fungus, of which there are several varieties. Of these the former is more common in London and Paris, but is rare in most parts of the Continent.

*Favus*, caused by the *Achorion Schoenleini*.

*Pityriasis rubra*, due to the *Microsporon furfur*.

*Keratomycosis*, or parasitic ulcer of the cornea, is due to fungi of the aspergillus type, and similar organisms may also affect the lungs (pneumomycosis) or the external auditory meatus (otomycosis).

The group *streptothrix* may be regarded as the lowest of the hyphomycetes, and its members possess many similarities to the bacteria. They are of importance in surgery, since their pathogenic members give rise to the group of diseases known as 'actinomycosis'. The streptothrices form long filamentous hyphæ, which are narrower

than those of the higher fungi, and which differ from the leptothrichal filaments sometimes exhibited by some bacilli in that they exhibit true branching. They form chain-spores, the protoplasm of the mycelial threads collecting in small masses separated by spaces in which the sheath is empty. These appear to be true spores, since they resist a temperature higher than that which kills the mycelium itself. The streptothrices are widely distributed, and many forms are known, of which but a few are pathogenic.

It is worthy of notice that the tubercle bacillus (as well as other organisms usually classified as bacteria) sometimes grows into long branching filaments. Hence some regard it as belonging to the streptothrices, and term it tuberculomyces.

3 The *protozoa*, or unicellular animals, are not of much pathological importance, except as causes of malaria and of the amoebic form of dysentery, and the hepatic abscesses associated therewith. The psorosperms which belong to this group cause disease in the lower animals, and are of interest in human pathology, since the peculiar bodies seen in Paget's disease and in molluscum contagiosum were once thought to be of this nature, though they are now known to be merely forms of cell degeneration. The 'cancer bodies' so frequently seen in malignant growths are held by some to be protozoa, and to be the cause of the disease, but this view has now been abandoned by most pathologists.

### Infection

Infection may be defined as the access of living, virulent, pathogenic bacteria to a region whence their toxins may act on the tissues of the body. Certain points in this definition require explanation. (1) It is interesting to notice that dead bacteria, especially dead tubercle bacilli, may cause pathogenic effects quite similar to those of the living ones. This, however, would scarcely be spoken of as infection, since one of our fundamental ideas of that process is that it can be transmitted from one sufferer to another indefinitely. (2) The question of *virulence* is one of the greatest importance. Many organisms vary enormously in this respect. For instance, the *Streptococcus pyogenes* is often quite devoid of virulence to rabbits, the injection of large amounts of pure culture being followed by no bad results of any sort, and yet it is possible to exalt the virulence of the same culture enormously, so that an extremely small dose (possibly a single coccus) may cause death. This *evaluation* of virulence is usually accomplished by 'passage' through animals, an animal being inoculated with large doses of the organism, and cultures from this animal being taken to inoculate the next, and so on, until many animals have been inoculated in series. Probably something of the sort occurs under natural conditions, for an organism taken directly from a patient is usually much more virulent than one that has been cultivated in the laboratory. Thus, a slight post-mortem wound infected from a case of streptococcic peritonitis is usually



very severe, indicating a very high degree of virulence in the organism. In general, we know little or nothing of the causes which lead to increase of virulence under natural conditions. The outbreak of an epidemic of small-pox, for instance, must be due to a sudden increase in virulence of the specific organism, but the causes which lead to this are quite obscure.

Cultures of an organism of diminished virulence are said to be *attenuated*, thus vaccine is a culture of the unknown small-pox organism in an attenuated state. The artificial attenuation of pathogenic bacteria is a subject of great importance in connection with the production of immunity, and it may be laid down as a general rule that the cultivation of an organism under slightly disadvantageous conditions tends to diminish its virulence, and *vice-versa*. For example, the anthrax bacillus grows best at  $37^{\circ}\text{C}$ , or thereabouts, and retains its virulence for long periods at this temperature, but if it is cultivated at  $42^{\circ}\text{C}$  it becomes attenuated. Cultures thus treated constitute Pasteur's vaccine against anthrax, when injected into animals they cause transient ill effects, but the animal becomes immune to the disease.

(3) The organism must be *pathogenic*, if infection is to occur, and by this we mean capable of producing disease in the animal in question. Thus, the inoculation of the gonococcus into the urethra of animals leads to no results, and infection does not take place. Hence two factors must be present: the organism must be virulent, and the host susceptible.

(4) Lastly, an essential feature of infection is that the toxins of the organism must act on the tissues of the host. Thus, it is quite possible, and not uncommon, for streptococci to be present in the outer layers of the skin, and the *B. diphtheriæ* in the mouth, etc., and yet for no harmful effects to arise, since either the organisms do not form toxins, or else these toxins do not reach the tissues. This is not infection, although in such cases any slight lesion or any condition leading to local or general lowering of resistance may bring it about.

A good deal of confusion has existed between the terms 'contagion' and 'infection', and it is well to explain that by *contagious* is meant a disease which can be transmitted to a healthy person by direct contact with the infected individual, or by the direct transmission of the virus through an intermediate individual or object, *provided that the organism has not multiplied outside the body*. Syphilis is eminently contagious, either directly, from one person to another, or indirectly, as by smoking an infected pipe. Thus, contagion is merely a limited type of infection.

The terms *specific* and *non-specific* as applied to infectious diseases also require explanation. A *specific* disease is defined as one which is produced by a single cause—*i.e.*, a particular species of micro-organism, and by no other. Thus, tetanus is a well-marked pathological entity, always due to the *B. tetani*, and may be taken as the type of a specific infection. Suppuration, on the other hand, may be

caused by a large number of species of bacteria, or even by chemical irritants, and is therefore termed non-specific. The boundaries of these divisions are constantly changing with the advancement of pathological research. The common process is for diseases which are apparently homogeneous to be split up into groups of specific diseases, each due to its own organism. Thus, ringworm is now known to be due to several different forms of fungus, and combined clinical and pathological research have shown that the diseases due to one variety differ in minute points from those due to another. Again, actinomycosis was formerly thought to be a specific disease due to a single micro-organism, but it has been found recently that many organisms may produce it. The reverse process is sometimes seen, several apparently different diseases being united together on the discovery of their cause. For example, malignant pustule and wool-sorter's disease are apparently quite distinct maladies, yet since it has been found that they are both caused by the *B. anthracis* they can now be included as manifestations of one specific disease.

**Local Infective Processes** are those caused at the site of inoculation by the growth and development of the microbes. After a period of incubation—which varies with different organisms, and during which we may imagine that they are struggling with the germicidal action of the tissues, and establishing their foothold in the body—the bacteria begin to grow and multiply, and by the deleterious products of their activity cause irritation of the tissues and various degrees of inflammation.

These inflammatory foci may remain limited, or diffusion may occur by the bacteria spreading with more or less rapidity by continuity of tissue or along lymph channels, or the organisms may be widely disseminated through the body by the bloodvessels in the shape of emboli. A certain amount of constitutional disturbance may accompany these manifestations, due to the absorption of the toxins produced locally, whilst in some diseases the general toxic symptoms (or toxæmia) associated with some local mischief may be extremely severe, as in tetanus and diphtheria. Hence local infective processes may be classed in two divisions: (a) those in which there is but little or no general toxæmia, such as a soft chancre, a tuberculous abscess, or a mild attack of gonorrhœa, and (b) those in which the toxæmic condition is well marked, as in erysipelas, tetanus, diphtheria, etc., the character of the symptoms varying necessarily with the different toxins.

Many of the organisms which are the causes of local infection may also develop generally in the system, and produce grave constitutional affections.

**General Infective Processes** are those in which the organisms develop and multiply in the blood-stream, so that inoculation of a sound person with the blood would almost certainly [transmit the disease if a sufficient dose were introduced]. Many of the bacteria producing local infection give rise to these general diseases, and, indeed, in surgery we rarely see the latter without some local

condition being present to explain its origin. Septicæmia, pyæmia, acute tuberculosis, the second stage of syphilis, anthracæmia, and probably the exanthemata, are illustrations of general infection (see Chapters IV and VII)

### Immunity

Under ordinary circumstances every living animal is constantly exposed to possible sources of infection. Bacteria are present in the air we breathe, in our food, drink, etc., as well as on our skins and in our alimentary canals. It is obvious, therefore, that there is some potent natural means of resisting the attack of these organisms, and that it is only when these means break down or are insufficient that infection occurs. This power of resisting the invasion of micro-organisms is termed *immunity*, and it is the exact opposite of *susceptibility*. Further, the process of natural cure of any infective disease is brought about by the production of such a degree of immunity (whether local or general) as shall suffice to destroy the causative bacteria. It is therefore obvious that the study of immunity is of the greatest importance in connection with the prevention and cure of disease, and the more so since the most potent artificial methods of accomplishing these ends are those which imitate, or stimulate, or give free play to, these natural processes. A brilliant example of this is seen in the modern treatment of diphtheria by means of antitoxin, in which the natural cure of the disease is imitated exactly by artificial means. Unfortunately, however, the forces concerned in immunity are still very imperfectly understood, although an enormous amount of work has been devoted to their elucidation, and it is in but few cases that the practical application of our scientific knowledge has been followed by such happy results.

**Natural Immunity** is that which is inherent in the constitution of the animal when born, and not due to any event taking place in its life history. Thus the lower animals are all naturally immune to gonorrhœa and many other diseases which affect man, whereas man is naturally immune to many of the diseases of the lower animals. In most cases natural immunity is general throughout all the members of the species, but this is not always the case. For example, some children are absolutely immune to vaccinia, though the vast majority are susceptible. Hence racial immunity is not quite identical with natural immunity.

It must be clearly understood that there is no absolute standard of immunity, since the reaction of the tissues varies between the highest degree of susceptibility and the highest degree of immunity. Thus, if several animals are inoculated with equal doses of the same bacterial culture, one may show no ill effects, another may exhibit a slight amount of inflammation at the site of inoculation, a third may acquire a spreading inflammation, which may progress to supuration or gangrene, whilst a fourth may develop a fatal general infection. Further, an animal may be highly immune to an organism

of ordinary virulence, and at the same time highly susceptible to the same organism when its virulence is exalted

Again, it is of the utmost importance to realize that the immunity or susceptibility of any animal to a given bacterium is not a definite fixed amount, but that it varies from time to time, and is greatly *influenced by external and internal conditions*. A study of these conditions is of fundamental importance in the prevention of disease. We may regard it as certain that man possesses a very considerable degree of immunity to nearly all bacteria (including even the tubercle bacillus), and it is only when this immunity becomes lowered by causes which depreciate the general or local vitality that infection occurs. These causes may be divided into two groups, local and general.

Of the general causes, cold and wet, especially if combined, are perhaps the most potent, but the method in which they act is still uncertain. Starvation and malnutrition are also important, and even in slight degrees have a very decided effect on immunity. Thus it has long been recognised that post-mortem wounds received when fasting are more dangerous than those received when digestion is in progress. In this case we may perhaps correlate the immunity with the increased number of leucocytes in the blood during digestion, but it does not appear to be a constant fact that a large number of leucocytes always implies a high grade of resistance, and *vice-versâ*. Age is an important factor, children being, as a rule, much more susceptible than adults. Immunity is also greatly reduced by hæmorrhage, and by certain poisons, particularly alcohol. Prolonged exposure to a vitiated atmosphere is also a very potent factor, especially in the production of susceptibility to the tubercle bacillus. Prolonged anæsthesia also lowers the general resistance of the body, as also certain diseases, notably Bright's disease and diabetes.

The local causes include injury, especially bruises, contusions, burns, and the irritation due to chemical substances. This latter condition is often used in the laboratory to exalt the virulence of certain bacteria. Thus, pyogenic cocci are often without action on rabbits, even in tolerably large doses, but if injected together with some dilute lactic acid, the toxins of other bacteria (such as *B prodigiosus*), or other soluble irritant, they are frequently enabled to develop and produce pathological effects. Considerable surgical importance is attached to this observation, since it must not be forgotten that nearly all antiseptics are irritant, and if applied in too concentrated a state or for too long may lower the local resistance, and render the wound more liable to be infected by any organism that may at the time or subsequently gain accidental entrance. The local application of cold or hot liquids has a similar action, and hence all fluids used to wash out wounds or body cavities should be used exactly at blood heat, unless the direct effect of the heat or cold is required. Lastly, a local deficiency in the blood-supply, due to disease in the blood-vessels or elsewhere, or to tight bandaging, pressure, etc., also renders a part less resistant to infection.

**Acquired Immunity** is of two kinds—active and passive

*Active immunity* results from a previous attack of the disease, either natural or due to artificial inoculation, so that the individual is freed from the risk of contracting it again. Syphilis and the exanthemata are good illustrations of diseases conferring an active immunity, which, however, is not always absolute, since well-confirmed examples of second attacks, even of syphilis, have been recorded. On the other hand, it is doubtful whether tuberculosis and the pyogenic diseases are capable of producing immunity.

The following are the most important artificial methods of bestowing active immunity. (1) Inoculation of the disease as it occurs in nature. This is of course a dangerous method, since the attack is almost as severe as one acquired in the normal way. It was formerly practised as a preventive of small-pox before the introduction of vaccination. (2) Inoculation with the virus of the disease or its causal micro-organism in a mitigated state. Vaccination is the best example of this process, the lymph employed is a culture of the small-pox organism (the exact nature of which is at present not definitely known) in a state of diminished virulence. Pasteur also applied the same method in the prevention of hydrophobia (p. 127) and of anthrax in cattle, the 'vaccine' in the latter case being a living culture of anthrax bacilli mitigated by being cultivated at a high temperature. (3) Injection of dead cultures of bacteria is used in the preventive inoculation against plague (Haffkine) and against typhoid fever (Wright). The cultures are killed by heat, and small doses injected subcutaneously. The result is a local inflammatory reaction of varying severity, together with general symptoms, such as fever and malaise. When these have passed off, the patient has acquired some immunity to the disease, so that he is now able to withstand the injection of a dose of the living culture, by which means the immunity is greatly increased. Koch's new tuberculin (TR) is of a similar nature, it consists of an emulsion of finely comminuted tubercle bacilli which have been killed by a process of grinding. Repeated injections are necessary, and the dose must be gradually increased as toleration is acquired. Good results have been obtained from its use, especially in certain cases of tuberculosis of the bladder. (4) Injection of the extracellular toxins of the causative organism is not used in man, but it is of the utmost value in immunizing the lower animals for the preparation of curative sera, especially antidiphtheritic and antitetanic. The horse is chosen for this purpose, since it is easy to handle, and yields a large amount of serum at each bleeding. The principle of the method is simple. A small quantity of the toxin (which has been filtered to remove living bacteria) is injected subcutaneously. It causes local inflammation, fever, and malaise, but when these have quite subsided, another and slightly larger amount of toxin can be tolerated. In this way the dose is gradually increased, until the animal is so resistant that the injection of enormous doses of most powerful toxin will produce but slight and transient ill-effects. In actual practice this method is

usually modified, the earlier stages being considerably shortened by the injection of a mixture of toxin and antitoxin, or by the use of peculiar forms of toxin of diminished activity

It will be noticed that in all these methods the animal which subsequently becomes immune combats with and overcomes the organism or its toxin, and is always rendered more or less ill (in some cases very slightly) by the process. For this reason it is termed an active immunity—*i.e.*, it is acquired by the animal's own active combat with and victory over the disease

Passive immunity is that which is conferred on an animal without effort on its part by the injection of serum from an animal that has already acquired an active immunity against the disease in question. For example, if some of the serum from a horse which has been actively immunized against tetanus is injected into a second horse (or other animal), the latter will also become immune to the tetanus bacillus or to its toxin. The second animal is not rendered ill by the injection, and is merely the passive recipient of protective substances which have been elaborated by the first. The fact that the injection of these sera into man sometimes causes transient ill-effects, such as fever, joint-pains, rashes, etc., in no way modifies the truth of this statement—the phenomena in question are largely due to the antiseptic used to preserve the serum, and are not necessary antecedents of the production of the passive immunity

Passive immunity cannot be bestowed by the injection of serum from an animal which is naturally immune—the lower animals, for example, are naturally immune to syphilis, but their serum has no protective or curative action in man. The diseases in which the serum has the greatest practical value for protection or cure are those in which the specific micro-organisms produce extracellular toxins, especially diphtheria and tetanus

✓ Active and passive immunity also differ in other respects. Passive immunity is produced immediately the serum is injected, whereas active immunity is only developed slowly after the injection of the toxin, or of the living or dead culture, in general, a week at least must elapse before the full degree of immunity is produced. Again, passive immunity lasts a comparatively short time, unless, of course, the dose of the immunizing serum is repeated. In the case of a prophylactic injection of antidiphtheritic serum in man the duration of the immunity is about a couple of months. Active immunity is usually much more lasting, though its duration varies greatly in different cases. In most cases of syphilis and small-pox it is permanent, second attacks being extremely rare, whereas in pneumonia it is of very short duration

When we turn to the theories which have been promulgated to explain the facts briefly outlined above, we must bear in mind that there are two groups of phenomena which require elucidation—the immunity to the bacteria and the immunity to their toxins. Thus, if we inject a culture of living diphtheria bacilli together with their toxin into a susceptible animal, the bacilli will continue to grow in

its tissues, and the toxin will exert its poisonous effects, both local and remote. If we inject the same culture into an immune animal (whether the immunity is natural, active, or passive), the bacteria will be killed and the toxin will have no action. We will discuss bacterial immunity first.

Omitting theories which are merely of historical interest, we come first to the *humoral theory*, which asserted that the destruction of the bacteria was due to certain substances which are present in the blood, lymph, etc., and which were designated *alexins*. The experimental foundation for this theory consists in the fact that fresh blood, and more especially fresh blood serum, has very considerable bactericidal action. This action is destroyed if the serum is exposed to heat (about 60° C for half an hour), and disappears spontaneously after a day or so, when the alexins have been destroyed by either process, the serum becomes an excellent culture medium for most bacteria.

*Metchnikoff's theory of phagocytosis* (the *cellular theory*) was at first in strong opposition to the humoral theory, but subsequent researches have brought the two closer together. Starting from the fact that unicellular protozoa (such as the amoeba) ingest, digest, and assimilate the bacteria found in water, Metchnikoff was led to examine the action of the leucocytes, or wandering cells of the higher animals, which in their morphology so strongly resemble the lower protozoa, and found in them a similar power of engulfing and digesting living micro organisms. This process he termed *phagocytosis*. A striking example occurs in *Daphnia* (the fresh-water flea), an animal which is so transparent that the whole phenomenon can be followed under the microscope during life. It is affected with a disease due to the growth in its tissues of a fungus known as *Monospora*. The spores of this parasite are taken in with the food, and penetrate from the alimentary canal into the body cavity, when unchecked, they continue to grow until the whole animal is filled with growth. If, however, but few spores gain access, the defensive mechanism comes into play, and the spores are surrounded and engulfed by the leucocytes, submitted to a process of digestion, and finally destroyed. It is obvious that *Daphnia* is partially immune to *Monospora*, and that the immunity depends on the phagocytic activity of its leucocytes. Metchnikoff had no difficulty in finding many examples of the same process in man and the higher animals. If, for instance, a culture of a non-pathogenic organism is injected into the peritoneal cavity of an animal, and portions of the peritoneal fluid are examined from time to time, the bacteria will be seen first lying free, then engulfed in the protoplasm of the leucocytes, but retaining their normal appearance and staining reactions, then less distinct and refractile than before, indicating that they have undergone partial digestion, and in this state they stain badly. Similar appearances may also be seen in sections of tuberculous tissue, especially those that are healing, though here the phagocytic cells are not leucocytes, but epithelioid or giant cells.

The leucocytes are attracted to the region of the bacteria owing to

the fact that the latter give off soluble substances for which the leucocytes have an affinity, so that they move into the region in which these substances exist in a high state of concentration. This process is known as *chemotaxis*, and it is one which is widely distributed throughout the lower members of the animal and vegetable kingdoms. If, for instance, a capillary-tube filled with meat-extract is placed in a watery emulsion of typhoid bacilli, the latter will be attracted by chemotaxis and enter the tube. Similar phenomena are seen in the formation of an abscess: the pyogenic bacteria give off substances which attract the leucocytes, so that they soon become surrounded by a zone of these cells, and at the same time some of these substances gain access to the blood and attract the leucocytes from the bone marrow, giving rise to a general leucocytosis.

Metchnikoff found that in cases where phagocytosis was active recovery usually took place, and that when it failed the bacteria continued to grow and death occurred, from this he argued that immunity depends entirely on the leucocytes. He further noted that in animals with acquired immunity the leucocytes had gained the power of ingesting the bacteria, although previously unable to do so, hence he explained acquired immunity as being due to the education which the leucocytes had gained during the previous attack. The opponents of the theory urged that only dead, or at least non-virulent, bacteria were taken up by the cells, but Metchnikoff's great technical skill enabled him to isolate bacilli that had been actually ingested by leucocytes and prove them to be living and virulent.

The theory of phagocytosis was never generally accepted in its original form, and it was soon found not to apply in certain cases. Thus, it is possible to enclose active bacteria in a collodion sac, which will allow the transudation of body fluids, but will prevent the passage of leucocytes; if such a contrivance is placed in the peritoneal cavity of an immune animal, the bacteria are often killed. Further research also showed that even when bacteria are ultimately destroyed by phagocytic activity they may lose their definite outline, refractivity, etc., and give other indications of being injured whilst still free and extracellular. The fact that this extracellular injury or destruction usually occurs when the bacteria are surrounded by leucocytes led to the theory that the alexins are formed from or secreted by the leucocytes. This is the *cellulo-humoral theory*, and it may be regarded as a compromise between the two views enunciated above. It agrees with the humoral theory in regarding the destruction of the invading bacteria as due wholly or partly to soluble substances present in the body-fluids, and with the cellular theory in attributing to the leucocytes the paramount rôle in the defences of the body, but differs from it in allotting to them a double action, partly chemical and partly phagocytic.

Many facts go to prove that there is much truth in this compromise, but it is not a complete explanation. Thus, Behring's investigations on the subject of passive immunity, especially in connection with diphtheria, introduced a new element and opened up a



fresh field of research. It was found possible to cure the disease by a suitable serum or antitoxin which has no bactericidal effect whatever, so that its activity cannot be attributed to alexins or other bactericidal substances.

Metchnikoff explained its practical value by attributing to it the power of stimulating the leucocytes to more vigorous phagocytic action, but this view can no longer be sustained, though, as we shall see, it has a substratum of truth. Further researches showed that the action of the antitoxin is an extremely simple one. It unites with its specific toxin, and forms a compound which is devoid of toxic properties. It is unnecessary to give the full evidence on which this statement is based, but one single proof may be mentioned. Several bacteria—amongst others the tetanus bacillus—produce toxins which have the power of dissolving red blood corpuscles (hæmolysis), hence these substances are called the bacterial hæmolysins. Experiments on hæmolysis can be carried out *in vitro*, and it is thus possible to avoid all complications arising from phagocytosis or the action of the living tissues. Now it is found that tetanus antitoxin will prevent the hæmolytic action of the hæmolysin of the tetanus bacillus in the test-tube as well as in the body. Here, therefore, there must be merely a simple process of chemical neutralization, which may be compared with the action of an alkali on an acid.

The discovery of the antitoxins for diphtheria and tetanus led to numerous attempts to form similar substances for other poisons. It was found impossible to produce antitoxins for the alkaloids, mineral poisons, etc. Antitoxins were, however, prepared for snake-venom, eel-serum, abrin, ricin, etc., and for some other bacterial toxins. These poisons have these factors in common: they are all formed in living organisms, whether animal or vegetable, and they are all proteids or closely-allied substances.

The *method of action of the antitoxins* throws a certain amount of light on the mechanism of some forms of immunity. It has no bearing on natural immunity, for the blood of an animal which is naturally immune, say, to tetanus, does not contain tetanus antitoxin, but in recovery from tetanus the antitoxin appears in the blood. When this happens, any fresh toxin that the bacilli form will be immediately neutralized, and the latter will thereby be deprived of their power to injure the cells of the animal, and can be dealt with by phagocytosis or other means. In the production of passive immunity similar phenomena take place, the antitoxin artificially injected in the blood combines with the toxin and shields the cells from its action.

But this leaves the *method of formation of these antitoxins* unexplained. Several theories have been advanced to account for this phenomenon, but the only one of importance is *Ehrlich's side-chain theory*. It is somewhat complicated, but the brilliant way in which it accounts for the chief facts, and its profound influence on modern ideas of pathology, justify a brief outline of its more important features.

A toxin possesses two properties, that of poisoning a cell and that of com-

binning with antitoxin, and Ehrlich proves that these two functions reside in different portions of the molecule. To the part that unites with antitoxin he gives the name 'haptophore,' whilst the toxic portion is termed the 'toxophore.'

Ehrlich next assumes that a molecule of living protoplasm may be considered as consisting of two parts. One discharges the function of the cell of which it forms part, whilst the other subserves the nutrition of the former more highly differentiated portion, and has the power of uniting with molecules of proteid dissolved in the blood or lymph, and then building them up into living protoplasm. This function is supposed to be accomplished by side chains, or specialized portions of the cell, which unite with the molecules of food proteid. We must assume that these latter contain a haptophore group similar to that of a molecule of toxin, but no toxophore group, so that the first step in the nutrition of the cell consists in the union of a side chain with the haptophore group of a molecule of proteid, a process which Ehrlich compares with the seizure of particles of food by the tentacles of a sea anemone. Further, there are many varieties of proteids in the blood, and the molecules of each of these must have their own peculiar haptophore groups. Each haptophore group must 'fit' a side-chain (like a key fitting a lock), or it will be useless for nutrition.

Let us apply this view to the action of a toxin, remembering that the toxins are proteids or similar substances. If we inject a solution, *e.g.*, of tetanus toxin into an animal, it may happen that the side chains carried by the animal's cells do not possess haptophore groups which 'fit' those of the toxin. In this case no poisoning can occur, as the toxin cannot unite with the cells. If the cells do possess such side-chains they will unite with the haptophore of the toxin, just as if these side chains had seized a nutritious molecule. But the toxophore radicle is now brought into action, since it is united to the cell by means of the haptophore group and side chain. We may suppose it exerts an injurious influence similar to that of an enzyme, and the integrity of the functioning part of the protoplasmic molecule is destroyed. In other words, the first step in the intoxication of a cell by a true toxin is exactly the same as the first step in cell nutrition.

Suppose, now, that a certain number of the side chains are fixed to molecules of toxin, and that the living molecule is injured, but not fatally. The side chains are necessary for the nutrition of the cell, and those that are rendered useless must be regenerated, just as a hydra replaces a lost tentacle. If a second dose of toxin is given this process is repeated, and if we continue to administer toxin in suitable (non lethal) doses, we may gradually 'train' the cell to produce side chains more and more rapidly. But it often happens that the reaction of a living tissue is much greater than the stimulus demands, *e.g.*, the formation of callus is disproportionate to the amount of bone to be replaced. We must assume this to happen in the production of antitoxins. The cell produces more side chains than it has any necessity for—more indeed than can remain united with it, and the superfluous ones detach themselves from the cell and float off in the blood. They still retain their power of uniting with the haptophore group of a toxin molecule, thereby rendering the toxin inert, and thus they constitute antitoxin.

It would take us too far to discuss the evidence that has been brought forward in support of this theory, but one remarkable point may be noticed. For a cell to be poisoned by a given toxin, it is necessary that it should contain side chains which 'fit' the haptophore group of that toxin. But antitoxin consists of such side-chains, so that it follows that any cell which can be poisoned by a toxin may be made to produce an antitoxin to it. There is evidence that this is the case in tetanus, the toxin of which (tetano spasmin) acts only on the cells of the central nervous system. It was found by Wassermann that an emulsion of the gray matter of the brain has the power of neutralizing tetanus toxin just as antitoxin has, but that this power is lacking from emulsions of other tissues. Thus the cells of the central nervous system are the only ones which have side chains that can unite with the tetanus toxin.

Again, we should not be surprised if some of these side chains were to break off and pass into the blood under natural conditions. This actually happens, for traces of antitoxins (and other 'antibodies') frequently occur in normal blood.

Ordinary chemical poisons do not give rise to the formation of antitoxins since they do not unite especially with the side chains as if they were nourishing proteids, but form chemical combinations with all parts of the molecule indiscriminately.

It was soon found that substances allied to antitoxin might be obtained by the injection of proteid substances other than toxins into living animals. These are known as *antibodies*, the term being used to include *precipitins*, *agglutinins*, *cytolysins*, *bacteriolysins*, etc.

*Precipitins* are substances formed by the injection of proteid solutions, and have the property of forming a precipitate when mixed with a solution of the same proteid as was injected. Thus if a solution of egg albumen is injected into a rabbit, the serum of this animal (after a week or so) will give a flocculent precipitate with egg albumen, but not with other proteids. The precipitins are not known to have any bearing on the question of immunity except in that they form an example of the general law that if any foreign proteid is injected into a living animal it gives rise to the production of an antibody.

*Agglutinins* are formed by the injection of bacteria, red blood corpuscles, cells, etc., and they have the power of causing the cells injected to collect into clumps. A special case of great importance is in typhoid fever, where the agglutinin is formed early in the disease and is of diagnostic value. In most infections this is not the case. Thus in pneumonia the serum rarely shows any power to agglutinate the pneumococcus before convalescence is established. They are, however, of value in that they often enable the bacteriologist to prove the causal relationship of an organism and the disease it is supposed to produce. Thus in the investigation of the pathology of dysentery various organisms are isolated from the stools, and if one of these is found to be clumped powerfully by the patient's own serum it affords strong proof that it is really the infective agent. The agglutinins are also useful as proving the identity of an organism which has been isolated in culture. For example, if a culture of an organism resembling the typhoid bacillus had been isolated from the stools in a case of suspected typhoid fever (or from drinking water, etc.), the first test applied to establish its nature would be to see if it clumped with the serum of an animal which had been injected with a known culture of typhoid bacilli.

Agglutinins are antibodies to the proteids contained in the cells injected. They differ from the simple antibodies (antitoxins) in that they are formed of a complex side chain which contains a radicle which unites with the haptophore group of the proteid, and another radicle in which resides the 'clumping' properties. The latter can be destroyed by heat and the agglutinin then retains its power of uniting with the cells, but does not clump them. Agglutinins are not known to play any part in the production of immunity, and their presence in the blood does not necessarily indicate that the animal is immune, though this is usually the case.

The next group of antibodies—*cytolysins* (including the *bacteriolysins*, *hemolysins*, etc.)—are of great importance in the doctrine of immunity, and are much more complex in their structure and action than the preceding. The earliest indication of their existence was obtained by Pfeiffer, who immunized guinea-pigs to the cholera vibrio, and when the immunity was fully established injected a culture of that organism into the peritoneal cavity. Some of the peritoneal fluid was withdrawn from time to time, and the organisms therein examined microscopically. They were found to undergo remarkable changes, losing their shape, becoming spherical, and finally undergoing complete solution, the whole process often takes half an hour or so. This is called *Pfeiffer's reaction*, and is specific—*i.e.*, the peritoneal fluid of an animal vaccinated against cholera has no effect on the typhoid bacillus or any organism other than the cholera vibrio or its congeners. Further research showed that the

reaction can be obtained *in vitro*, provided that the peritoneal fluid is perfectly fresh, if, however, the fluid is kept a day or two, it loses this power, but regains it if mixed with perfectly fresh serum, whether this be taken from a normal or from an immunized animal. Thus

Fresh normal serum + cholera vibrios = no reaction

Fresh serum (or peritoneal fluid) from immunized animal + cholera vibrios = solution

Stale serum from immunized animal + cholera vibrios = no reaction

Stale serum from immunized animal + fresh serum from normal animal + cholera vibrios = solution

We deduce from this that *two* substances are necessary for the solution of the organisms in the tissues of an immunized animal. One occurs only in the fluids of the immunized animal, not in a normal one, and is an antibody similar to the agglutinins, but more complex, it has received many names, and is usually known as *amboceptor*, or *substance sensibilatrice*. The other occurs in normal blood, as well as in the blood of the immune animal, and is very fragile, rapidly disappearing when the fluid is kept, it is also readily destroyed by heat. It is probably the same as the alexin referred to above in connection with the humoral theory of immunity, but German writers usually term it the *complement*.

Further research on the antibodies of this group have been greatly facilitated by Bordet's discovery of the production of hæmolysins by the injection of blood from one animal into another of a different species. Thus, rabbit's serum is without effect on the red corpuscles of a horse, but if the rabbit is injected with a horse's red corpuscles, its serum acquires the power of dissolving or hæmolyzing them. These hæmolysins apparently act in exactly the same way as do the bacteriolysins in Pfeiffer's reaction, and are much more convenient for experimental purposes. Further, it appears that the reaction is a general one, and that cytolsins can be prepared for spermatozoa, liver and kidney cells, cells of the central nervous system, etc., and that in each case the reaction depends on a stable antibody or amboceptor and a labile ingredient of normal blood, the complement or alexin.

When one of these cytolsins is mixed with the cells which it dissolves (bacteria, red corpuscles, etc.) the first step in the reaction is the combination of the amboceptor with the cell; this takes place at a low temperature, and the cell is apparently unaltered. The next step is the combination of the alexin with the amboceptor (or, according to another view, with the cell which has now become 'sensitized'), and this takes place only at the body temperature. The third step is the solution of the cell by the complement acting through the amboceptor apparently by a kind of enzyme action. Hence a molecule of amboceptor must have two haptophore groups, one to unite with the side chain of the cell, and one to unite with a molecule of alexin.

Let us apply these facts to the production of acquired immunity—*e.g.*, to the immunization of an animal by injections of small doses of cholera vibrios. At first the organism continues to grow in the tissues, the only force which we know to oppose it at this stage is the action of the phagocytes, for the alexins or complements are unable to act, since they cannot unite directly with the bacteria, and there is no amboceptor. After a time the cells of the host begin to form antibodies to the proteids of the bacterial protoplasm. Some

of these may be antitoxins, which prevent the further intoxication of the animal, others are agglutinins, which are without known value to the host, lastly, there are amboceptors which link the alexin or complement of the blood to the bacteria, and bring about the solution of the latter. The animal is now immune, and when any further invasion with cholera vibrios takes place the apparatus of amboceptor and complement is ready for the defence of the animal. Further, the serum of the animal contains amboceptor, and when injected into a second animal this acquires passive immunity, provided that a suitable alexin is also present. This is one of the practical difficulties which prevent the successful application of the bacteriolytic sera in medicine. The alexin present in the serum of the immunized animal soon disappears, and although an amboceptor which is formed in the blood of one animal is always capable of being 'activated' by the complement of the same animal, it cannot necessarily be activated by the complement of other animals. This question is one which is extremely complex, and is at present not thoroughly investigated, though we can hardly hope for any further advance in serotherapy until it has been elucidated.

The rôle of the leucocytes now acquires fresh interest. We have already seen reason to believe that alexin is derived from these cells, and some hold that they are also the main source of the production of amboceptor and the other antibodies. The study of these latter substances has afforded a further insight into the function of phagocytosis. It was found (by Mennes) that leucocytes from a normal animal had no power of ingesting virulent pneumococci, but that they acquired this power when mixed with the serum of an animal which had been immunized to pneumococci. Thus we may infer that immune sera have the power of aiding the action of the leucocytes presumably in virtue of containing an antibody which unites with the bacteria and renders them vulnerable. The antibodies which act in this way might be antitoxins, amboceptors, etc., but it is possible that they may be fundamentally different. Wright, who has investigated the subject from a clinical as well as from an experimental aspect, calls them *opsonins*, and finds that the amount which is present in the blood determines the degree of immunity to various infections. Thus, if the blood of a person who is highly susceptible to staphylococci is mixed with a culture of living staphylococci, very few of the organisms will be ingested by the leucocytes, the opsonin being deficient, if the person is resistant to the infection, the bacteria are readily taken up. Wright has also shown that by the subcutaneous injection of killed cultures of staphylococci it is possible to enhance the phagocytic activity of the patient's leucocytes when an infection has already taken place, and has applied this method of treatment in furunculosis, etc., with some success. This proceeding seems at first to be illogical, the patient is already unable to combat the staphylococci in the lesion, and it seems unreasonable to inject more. The explanation probably lies in the fact that the injection of the dead staphylococci into a

distant region calls forth a production of antibodies in that region, as well as in the local lesion. A similar explanation may be given of the use of TR in tuberculosis.

The sera (other than the antitoxins for diphtheria, tetanus, and snake-venom) which are used therapeutically are believed to depend, in the main, on bacteriolytic actions for their beneficial effects. The most important to the surgeon are the antistreptococcic and anti-pneumococcic sera.

## CHAPTER II

### INFLAMMATION

'INFLAMMATION is the succession of changes which occur in a living tissue when it is injured, providing the injury is not of such a degree as to at once destroy its structure and vitality' Such was the definition given in 1870 by Burdon Sanderson, and it is sufficiently accurate if we realize that the exciting injury usually involves the admission of a soluble chemical irritant, and in most cases of a bacterial toxin, we must also exclude from the process of inflammation the later stages of repair. Formerly inflammation was looked on by pathologists as always of a destructive and harmful nature, but at the present time bacteriological research has demonstrated that it is rather of a protective or conservative character, being Nature's means of limiting the advance of noxious micro-organisms, and of finally eliminating them from the system. Occasionally, however, the tissue reaction called into existence by bacterial invasion is so severe as to increase, rather than diminish, the risks of the patient.

The causes of inflammation are very varied and numerous. Most frequently it is due to the admission of bacteria, and we have already alluded (p. 15) to the conditions, local and general, which predispose an individual to such invasion, and thus render him more liable to an inflammatory attack. Apart from bacteria inflammation may be lighted up by (*a*) mechanical lesions, such as blows, sprains, tension, pressure, etc., (*b*) burns or scalds, (*c*) toxic bodies, such as acids, alkalis, or vegetable and animal poisons, and (*d*) the electric current, either in the form of lightning, or as applied by the surgeon, or through the agency of strong currents as employed for purposes of traction or illumination. It is but fair to state that not a few authorities look on the tissue reaction caused by these non-bacterial irritants as distinct from inflammation, limiting the latter term to conditions resulting from bacterial invasion. The phenomena, however, are identical up to a certain point, and we see no advantage in the suggested dissociation.

The actual *phenomena* of inflammation are perhaps best studied in the web of a frog's foot. If this is spread out and examined under the microscope, the following evidences of normal physiological

activity may be seen (a) the flow of blood through the vessels, as indicated by the movement of the corpuscles, the red ones, each separate from the other, flowing in the central or axial current, the leucocytes occasionally seen amongst the red, or here and there one may be noticed rolling lazily along in the inert corpuscle-free peripheral portion of the tube, (b) the constant rhythmical changes in calibre of the arterioles independent of the heart's action, and influencing in a marked degree the flow through the capillaries, and (c) the changes which occur in the pigment-cells, which represent the connective tissues of the part, and which are mainly due to the influence of light, the cells contracting or expanding as the light is increased or diminished

If now a crystal of common salt, or some such irritant, is applied to the web, the early vascular phenomena contributing to inflammation may be readily observed

## I The Vascular Changes in Acute Inflammation

A momentary contraction may perhaps be noticed in the arterioles of the part, but this is only apparent in inflammations produced artificially, and is of no known significance. It is followed by a condition of Hyperæmia of the inflamed area, as manifested by a rapid and lasting dilatation of the vessels, accompanied by an increase in the rapidity of the blood-flow (acceleration). This is a peculiarly vital phenomenon, and opposed to the hydrostatic law that when fluid is flowing through a tube or channel at a fixed pressure, if the lumen is suddenly widened, the rate of the blood flow is diminished. It is probably brought about by some change in the local vasomotor mechanism present in the smaller arterioles. This increased rapidity of the flow lasts for a while, and then the current gradually becomes slower and slower (retardation), as if an ever-growing obstruction existed to the passage of the blood, next a period of oscillation will be noticed, the crowded corpuscles swaying forwards and backwards, and finally a condition of stasis or still-stand is arrived at, which may or may not end in actual thrombosis or intravascular coagulation. During this period the relations normally maintained between the vessel walls and the varied constituents of the blood have obviously become modified, and this is due in all probability to certain invisible changes in the former and not to any alteration in the blood. Thus, almost as soon as dilatation occurs, the leucocytes collect along the walls in the periaxial inert layer, seeming, as it were, to fall out of rank, this process first commences in the veins, but can be observed in all the vessels. The red corpuscles also, which formerly had flowed along separately, now tend to adhere to the vessel walls and to each other, running into rouleaux.

The second factor in the vascular changes must now be considered, viz, Exudation, a proceeding which becomes evident at a very early stage. Every element in the constitution of the blood



participates in this process. It has been already mentioned that the *leucocytes* collect in the peri-axial layer, a phenomenon due partly to an alteration in the vessel wall, whereby it is rendered more 'sticky,' and partly to chemotaxis (p 19). The next change consists in the passage of the leucocytes through the vessel walls, especially those of the smaller veins and less often of the capillaries. The process is a strictly vital one, brought about by amœboid movement, a small arm or outgrowth of the leucocyte (*pseudopodium*) is inserted between the endothelial cells lining the vessel, whose cohesion has been probably interfered with by the inflammatory process. Into this arm the protoplasm of the leucocyte flows, still further separating the endothelial elements, and thus the cell passes through the wall into the surrounding connective tissues (Fig 2). The migration of

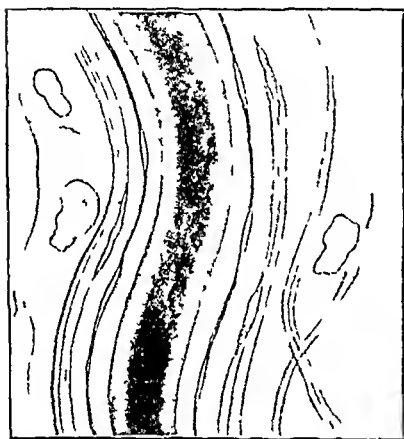


FIG 1

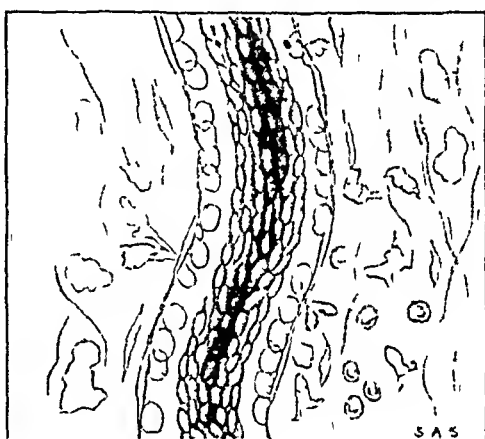


FIG 2

SEMI DIAGRAMMATIC REPRESENTATION OF THE VASCULAR PHENOMENA OF INFLAMMATION (AFTER THOMA)

(On the left is a normal vessel with its peripheral layer free from corpuscles, and its axial stream so rapid that the individual corpuscles cannot be seen. On the right is a similar vessel in a state of inflammation: the blood current has been retarded so that the individual corpuscles are visible, the leucocytes occupy the periphery of the vessel, and are in process of migration, whilst sundry red corpuscles can also be seen in the surrounding tissues.)

the leucocytes only lasts as long as the blood in the vessel is actually circulating, as soon as thrombosis occurs, migration ceases. When the white corpuscle has escaped into the peri vascular tissues, it may undergo various changes. In the first place, it may die and be at once disintegrated, setting free fibrin ferment, and thus assist in the production of the inflammatory coagulum to be shortly described, or, again, it may find its way back into the circulation through the lymphatics, or be transformed into a pus corpuscle, moreover, prior either to disintegration or transformation into a pus corpuscle, it may attack and assist in removing any dead tissue which exists in the neighbourhood of the inflammatory focus, whilst

a phagocytic or microbe-destroying function is also subserved. In fact, the leucocytes may be looked on as the scavengers of the body, or as advanced guards, which, at the onset of mischief, are thrown out from the vessels as Nature's first line of defence against the invading forces, their chief duty being to remove all damaged and noxious material, and then, having limited the spread of the destructive process, they in turn give place to the larger and more useful fibroblastic cells which are the active agents in the process of repair. At the present time the opinion is gaining ground that some at least of the fibroblastic cells are actually derived from the large mononuclear leucocytes.

The *red corpuscles* pass through the walls of the capillaries by a process of diapedesis, the result of simple mechanical pressure, this usually occurs only in acute attacks. When once external to the vessels they are broken up and their colouring matter diffused through the tissues, whence, as a rule, it is completely re-absorbed, in some cases, however, it may become converted into hæmatoidin or an analogous compound, and remain for years as the only evidence of the injury.

The *liquor sanguinis* is also extravasated. This is merely an exaggeration of a normal process, but to such an extent that although for a time the lymphatics of an inflamed region do increased work, yet the transudation is soon greater than they can deal with. If the fluid escapes into the tissues, it undergoes coagulation by meeting the necessary coagulating media developed from the breaking-down leucocytes, *inflammatory lymph* forms locally, whilst the *serum* collects in the meshes of the tissues, constituting an inflammatory form of œdema, if there is a sufficient breach of surface, the serum drains away. If the exudation takes place from a serous surface—e.g., pleura, peritoneum, synovial membrane, etc.—the fluid distends the cavity, it is at first spontaneously coagulable (i.e., consists of plasma), if coagulation occurs, the clot or lymph either forms an adherent plastic mass on the surface or floats free in the fluid.

Looked at, therefore, simply from a vascular point of view,

$$\text{Inflammation} = \text{Hyperæmia} + \text{Exudation}.$$

A few brief considerations may be offered as to the method in which the inflammatory reaction is of benefit to the patient, and we shall suppose that the process is caused by the presence in the tissues of a colony of bacteria, the toxins of which act as the irritant. The acceleration of the blood flow serves in the first place to dilute and to remove the toxin, if the amount present is small, the rapid flow of blood may serve to remove it completely, and then the process begins and terminates in hyperæmia. Further, the increased supply of blood must serve to keep the nutrition of the tissues at its highest level, so that if possible they may be preserved alive in spite of the action of the toxin. Lastly, if the blood contains antitoxins, or other antibodies, or alexins (complements), which inhibit the action

of the toxins or destroy the bacteria, these will be brought in large amounts to the region where they are required. We may regard the excessive transudation of the plasma as an additional means to fulfil the desiderata enumerated above. The value of the stasis of the blood is less obvious, and possibly it must be regarded as a necessary evil result of the action of the toxin, and not as part of the defensive reaction. It may be pointed out, however, that it probably assists the emigration of the leucocytes, which might otherwise find difficulties in attaching themselves to the walls when floating freely in a rapid blood stream. The role of the leucocytes has been touched on already. Their most important duty is to serve as phagocytes and to ingest bacteria, whether the latter are normal, or acted on by opsonins, or rendered innocuous by antitoxins. Moreover, we have seen reason to regard them as the probable source of alexins or complements, whilst other authorities consider that the defensive antibodies are mainly derived from them, and have ascribed to them the power of absorbing and neutralizing toxins.

In addition, however, to these vascular phenomena, which can be readily seen in a frog's web, there are others which cannot be so easily observed, and which may be described as

## II The Tissue Changes in Inflammation

Great differences of opinion have been in existence as to the part played by the tissues in inflammation, but although there are still many points to be elucidated, yet the general opinion of pathologists is at the present day tolerably well defined. Formerly, in accord with Virchow's cellular pathology, it was held that the tissues were the all-important element, and that the immense number of cells which collect in an inflamed area was entirely due to the proliferation of the connective-tissue corpuscles. Lister, as far back as 1858, maintained the passive condition of the tissues, and when Cohnheim, in 1867, described the migration of the leucocytes, everything in the process of inflammation was attributed to them. Since that date Sennleiben and many others have worked at the same problem, and a considerable amount of fresh light has been thrown on the subject by experiments consisting in the insertion of foreign bodies into the peritoneal cavity, and by others directed towards demonstrating the phagocytic functions of leucocytes and the influence of chemotaxis. Much of the difficulty which has enshrouded the question has arisen from a confusion between the processes of inflammation and repair. At one time repair was always looked on as of an inflammatory nature, but it is now admitted that although no lesion in the body can occur without a certain amount of local reaction, yet the true process of repair is not inflammatory. Again, it is important to differentiate between the changes which occur in acute and chronic forms of inflammation, and between those met with in superficial

and deep parts, whilst the bacterial origin or not of the process must also be taken into account

The reaction of the tissues in acute bacterial inflammations appears to depend entirely on the irritative power of the toxins, or rather on the relation of this power to the resistance of the patient's tissues. It may be laid down as a general rule that any irritant, if weak enough (*e g*, when very diluted), acts as a stimulant to the growth of cells, on the other hand, if sufficiently powerful it will cause some variety of necrosis or death of the tissues. Uncomplicated examples of tissue-overgrowth in acute inflammation are not often seen in man, since the slighter lesions are rarely examined microscopically. The process is best seen in the early stages of acute inflammations of the serous membranes in animals, where the endothelium may be seen several cells thick, whilst its nuclei show active mitosis, proving that cell-proliferation was in progress. An examination of the outer zone of a mass of granulation tissue (where the toxins are present only in small amount) will often show similar appearances. In most cases the process goes further than this, and the death of the tissue results. This may be brought about in several ways, of which perhaps the commonest is termed **coagulation necrosis**. In this condition the tissues and cells become soaked in the coagulable plasma which exudes from the vessels, and when they have been killed by the toxins a coagulation of the whole mass takes place. The result is that all structure disappears from the area involved: the nuclei cease to stain with hæmatoxylin or other basic dyes, and all the tissues stain uniformly with acid stains, such as eosin. The further history of the lesion depends on the nature of the causative organism. If this is one of the pyogenic bacteria, the necrotic mass will become (or has already become) infiltrated with polynuclear leucocytes, some of which are killed by the toxins, and suppuration follows (see p 59). When the organism is not of this nature, the polynuclear leucocytes make their appearance in but moderate numbers, and the inflamed area becomes infiltrated with 'small round cells,' which appear to be identical with lymphocytes. It is as yet uncertain whether these are formed locally or whether they are attracted from the blood. It seems, however, tolerably clear that they undergo a local increase by direct division in the inflamed area. If the bacteria are killed and the process stops at this stage the phenomena of repair supervene: these collections of small round cells become infiltrated by larger round or oval cells (fibroblasts), which gradually become elongated and develop into fibrous tissue, or perhaps into new bloodvessels. The lymphocytes now gradually disappear, and the lesion only differs from normal fibrous tissue in being immature both as regards its vessels and its fibres. The source of the fibroblasts has been the subject of much controversy, the whole question being whether they are derived from the pre-existing connective tissues or from the leucocytes. There is now but little doubt that they may have either origin.

In non-bacterial inflammations of superficial parts the amount of

effusion between the individual cells may be so excessive as to separate and disintegrate them, and thus colliquative-necrosis may be induced, as occurs in the formation of blisters after a burn

In chronic inflammations, on the other hand, active cell-proliferation is a most important element in the process, resulting in sclerosis and induration of the parts. This, however, mainly affects the interstitial tissues, and thereby the true structure of the organ may be impaired

It is obvious, therefore, that the Terminations of acute inflammation will vary considerably, and more especially with the cause of the trouble, whether bacterial or not, with the intensity and duration of its action, and finally with the powers of resistance possessed by the tissues and the individual

In bacterial inflammations (1) it is unusual for the tissues so to assert themselves as to permit of the occurrence of resolution, or the re-appearance of the *status quo ante*, it is, however, seen occasionally (2) More frequently local destruction of tissue results, and, according to the nature of the bacteria and the tissues involved, this may be followed by (a) rephal, the necrotic tissue disappearing and scar tissue taking its place, (b) suppuration, in which the affected tissues and the exudate are liquefied and transformed into pus, (c) ulceration, when the necrotic or suppurative process affects the surface, or (d) extensive necrosis or gangrene, when the toxic effects of the bacteria are able to break down the tissue resistance to such an extent that the bacteria are able to diffuse themselves widely in the part. In this connection it is interesting to note that the more highly organized and important parts are always more vulnerable than the simpler forms of connective tissue, and this in spite of the fact that the former are usually better supplied with blood. Thus, the growing end of the diaphysis in a child is a most delicately organized region, and hence is peculiarly liable to serious destructive inflammation from bacterial agents, which would do little harm if developing under similar circumstances in the subcutaneous connective tissues

When the inflammatory attack is due to mechanical or other non-bacterial causes, there is frequently much effusion of fluid, and at first but little cellular exudation, whilst the process is distinctly limited and has no tendency to spread. The most common terminations are (a) Resolution, complete and absolute, which is seen not uncommonly, (b) the formation of fibro-cicatrical tissue, as seen, e.g., after a localized colliquative-necrosis, or in the organization of lymph into adhesions after a simple synovitis, (c) sometimes the inflammatory process *becomes chronic*, and is then characterized by sclerosis or fibroid thickening of the part, or by persistent effusion into a serous cavity

Resolution, or the restoration of the part to its natural condition and function, can only occur when the injury has not been so severe as to destroy the vitality of the affected tissues. The phenomena are merely those of inflammation in a retrograde order—viz., an oscillatory movement first manifests itself amongst the corpuscles, and

then the blood-stream is gradually restored, slowly at first, and more and more rapidly afterwards. The adhesiveness of the corpuscles disappears by degrees, but it will be some time before the peripheral inert layer can be seen. The exuded leucocytes find their way back into the circulation either through the vessel walls, or to a greater extent *viâ* the lymphatics, or else they are disintegrated in the tissues and absorbed. The fluid exudate is removed by the lymphatics. For some time after an acute attack the vessels of the part, especially the veins, are dilated from simple loss of tone, but this also gradually disappears.

### Clinical Signs of Inflammation

These may for practical purposes be described under the four headings given by Celsus—*viz*, heat, redness, swelling, and pain, with the addition of a fifth—*viz*, impairment of function.

**Heat**—An inflamed part feels hot to the touch, and the temperature, if taken by a surface thermometer, is definitely raised above that of the surrounding skin. The cause of this is the increased amount of blood flowing through it, for the temperature of an inflamed area is never higher than that of the blood at the centre of the circulation, *ie*, in the heart. Necessarily, where active chemical and pathological changes are occurring, as in an inflamed tissue, a certain amount of heat is produced, but it is relatively so infinitesimal in quantity that it may be neglected. The cause of the increased temperature of the blood is noted elsewhere (p. 35).

**Redness** is due to the hyperæmic condition of the inflamed part, and its intensity and characters vary considerably. In the early active hyperæmia the colour is a bright rosy-red, fading quickly on pressure, and returning with equal rapidity. In the stage of retardation the redness is more dusky, since the blood is longer in passing through the capillaries, and so loses more of its oxygen, the colour does not disappear or return so rapidly, and a slight yellowish tinge often remains from extravasated hæmoglobin. When stasis is reached, and *a fortiori* when thrombosis, pressure does not remove the red colour, and, should such a state persist for long, permanent pigmentation may remain.

The redness is not always most marked at the focus of the disturbance, since the portion inflamed may be non-vascular, *eg*, the cornea or articular cartilage, in the former of these, the redness is most marked in the ciliary region as a zone of deep pink injection. The same absence of redness is observed in an inflamed iris, owing to the excess of pigment hiding the dilated vessels, but in both cornea and iris, the inflammation may in rare cases be so prolonged or acute as to cause these structures to become evidently vascular—in the one case from the formation of new vessels, and in the latter by the total removal of the pigment.

**Swelling** arises from the same two causes—*viz*, hyperæmia of, and exudation into, the part. Necessarily the amount of tumefaction depends upon the acuteness of the disturbance and the distensibility

of the tissue, and in measure varies inversely with the amount of pain. In some cases where the inflamed area is covered by a thick and firm fascia, not only is the tensive pain very considerable, but the chief swelling may occur away from the inflamed area, *e g*, over the back of the hand in a palmar abscess, where the inflammatory products escape into lax tissues, the subjective phenomena are minimized, although the swelling may be very great. Similar illustrations of the occurrence of œdema at a distance are to be seen in inflammations of the sole of the foot, in the swelling of the eyelids when the scalp is inflamed, and of the cheek in inflammation of the dental periosteum. Swelling due to inflammation, though diminishing post-mortem, does not entirely disappear.

**Pain**—This results from the mechanical irritation of the peripheral nerve terminals, both by the increased arterial tension and by the pressure of the exudation, so that it is much greater if, from the density of fascial or fibrous investments, swelling cannot readily occur, *e g*, in the palm of the hand, or in the eye or testicle. Possibly the exudation may also have some direct chemical action on the nerve terminals.

A marked feature of inflammatory pain is that it is always aggravated by pressure, whether intrinsic—*i e*, by increasing the blood-pressure—or extrinsic, from outside agencies. Thus, if an inflamed finger or hand is allowed to hang down, the pain is much increased, whereas elevation causes speedy relief.

The pain of *suppuration* is throbbing in character, of an inflamed *mucous membrane*, scalding, burning, or gritty, of an inflamed *serous membrane*, stabbing, of inflamed *bone*, aching or boring, and often worse at night, of an inflamed *testicle*, sickening. When the organs of *special sense* are inflamed, there may be little real pain, but much exaggeration of the special sense, *e g*, flashes of light in retinitis and noises in the ears in otitis interna.

The pain is not limited only to the inflamed part, but is sometimes experienced in distant regions, either through a similarity of nerve-supply or from the fact that a sensory stimulus is always referred by a patient to the end of the affected nerve. For example, in *hip disease* the chief pain is often felt in the knee, because the two joints have a similar nervous supply. In *renal calculus* or colic, pain is referred along the course of the genito-crural nerve into the groin and front of the thigh, and is often accompanied in the male by retraction of the testicle on the side affected. In *spinal caries* pain is frequently experienced in the terminal branches of the nerves issuing from the part affected, *e g*, the so-called 'belly-ache' of dorsal-lumbar disease.

**Impairment or Loss of Function** is due sometimes to the mechanical difficulty of using a swollen organ, sometimes to the pain elicited by such attempts, but often to the paralyzing effect of the inflammatory process, and this in infective lesions results from the direct influence of the toxins on the protoplasm of the cells affected. Thus, an inflamed eye is from various causes of little use for vision, a muscle, when inflamed, is naturally kept at rest, glandular organs, *e g*, the

liver and kidneys, have their functions, if not lost, at least much diminished, and many similar illustrations might be added

### General or Constitutional Symptoms

These vary considerably according to the part involved and the cause of the inflammation (a) If an important organ, such as the heart or kidney, becomes inflamed, grave mechanical and physiological trouble may result (b) Inflammations due to traumatism, in which bacteria play no part, are not uncommonly associated with a temporary pyrexia, probably due to some such substance as fibrin ferment (c) When of septic or pyogenic origin, inflammation is almost always associated with well-marked fever, and it is some times astonishing to note how much disturbance a small bead of pus under tension will produce (d) In certain infective inflammations a characteristic toxæmia is produced, due to a specific action of the toxin—e.g., in tetanus, convulsions are caused, whilst in diphtheria, fever and perhaps paralytic phenomena are alike produced

It is only necessary at this place to deal very briefly with the subject of **Fever or pyrexia**. The general characteristics of the febrile state consist in a greater or less elevation of temperature, accompanied by a corresponding acceleration of the rate of the heart-beat and of the respirations. If it continues for any length of time, the patient becomes thin and emaciated, and loses muscular power. The mouth is dry and the tongue furred, and in the later stages the lips and teeth are usually covered with sordes (or accumulations consisting of inspissated mucus and food débris). The appetite is impaired, digestion is imperfect, and the bowels constipated, any motion passed is very offensive. The urine is scanty and high-coloured, and owing to the excessive tissue change contains an unusual amount of urea and urates. The excess of urea is demonstrated clinically by adding an equal part of cold nitric acid in a test-tube to some urine, when crystals of nitrate of urea will form on the top of the fluid, giving rise to a mass somewhat resembling sugar-candy in appearance. The skin of a febrile patient is often dry.

*Causes of Fever*—The temperature of the body, it is well known, is controlled by a principal heat-governing centre in the medulla, assisted possibly by accessory centres in the cord, and is maintained by the establishment of equilibrium between the amount of heat lost from the skin by the breath, and in other directions, and the amount of heat produced by the tissue metabolism occurring in the viscera generally, and especially in the voluntary muscles. Pyrexia is necessarily due to one of two causes, viz., a decreased loss of heat, or an increased production. The former is a scarcely tenable proposition when we look at the patient's condition, and hence we are driven to conclude that fever is due to increased activity in the heat-forming tissues, especially the muscles—a fact which explains the rapid emaciation and loss of strength under such circumstances, and the presence of a large amount of extractives in the urine. In all probability this increased activity is due to the excitement of the heat-producing centre by some pyrogenous body developed in connection with the local inflammatory process. Experiments have shown that fibrin ferment and many of the



toxins produced by the action of micro organisms if injected into the circulation in a pure state, possess such a power

In regard to the symptoms of fever, it may be stated briefly that they are in large part due to the effect produced by the increased temperature or the toxic products circulating in the blood upon the constituent cells of glandular and other organs. The phenomena in question are termed by different pathologists 'acute or cloudy swelling,' 'granular degeneration,' 'albuminous infiltration,' etc., and are characterized by the organs becoming soft friable, and more or less swollen. The secreting cells of glands are increased in size and the protoplasm becomes markedly granular so that the nucleus can only be distinguished with difficulty. The granules are albuminous in character, clearing up completely on the addition of acetic acid. A similar change is also evident in the fibres of the cardiac muscle which lose their striation and become granular, a condition which must considerably interfere with their contractility. The effect produced upon the glands of the digestive system explains many of the febrile manifestations, inasmuch as their function is largely impaired. The salivary and buccal glands are unable to excrete the normal amount of saliva, and hence the mouth becomes dry. Gastric digestion is interfered with in the same way. The bile is not efficiently produced, and hence its fat emulsifying properties are diminished, as also its cathartic powers whilst the patient cannot properly digest fats and is constipated.

Various terms have been applied to different *types of surgical fever*, e.g., sthenic and asthenic, which sometimes depend as much upon the constitution of the patient as upon the nature or cause of the affection. By **Sthenic inflammatory fever** (Greek, *σθενης*, strength) is meant that condition in which pyrexia and all its accompanying symptoms are well marked. It occurs mainly in young healthy adults of sound constitution, as, for example, when a young man is suddenly attacked by acute pneumonia, or when an acute abscess is forming. **Asthenic inflammatory fever** (Greek, *ἀσθής*, without strength) is characterized by the tendency to exhaustion and collapse associated therewith. It is met with in debilitated subjects and those exhausted by vicious habits, but may also occur at the close of a long period of pyrexia, e.g., in the third week of typhoid fever (= the *typhoid state*). The absorption of products of putrefaction and the occurrence of acute infective blood-poisoning also induce fever of this type.

### Varieties of Inflammation

Many different terms are used to indicate the manifestations of the inflammatory process in the body, and to some of these we must now direct attention.

A **Catarrhal inflammation** is one affecting mucous membranes, which in the early stages become dry, vividly red, and the seat of a burning or scalding pain, whilst in the later stages there is free secretion of mucus, muco-pus, or pus. Pathologically, this process is accompanied, as are all active inflammatory changes, by hyperæmia and exudation. At first the mucigenous function of the membrane is abrogated, and any extravascular exudation passes into its substance, causing it to become swollen. Proliferation of the epithelium soon follows, resulting in an increased formation of mucus, as the membrane becomes more and more infiltrated with leucocytes, these are added to the discharge, which is thus trans-

formed into muco pus, or even pus. Small ulcers may develop from the loss of superficial epithelium, but this is an exception rather than the rule. Microscopic examination of the discharge reveals pus cells, leucocytes, and epithelial elements in various conditions, some containing globules of mucin, and some of the normal type. This form of inflammation is caused by bacteria, or by the action of local irritants, or to what is known as 'taking cold'.

A **Croupous** (or plastic) inflammation is one characterized by the formation of a firm, false membrane, due to the coagulation of the plasma exuded from the vessels, the resulting fibrin being deposited on the surface. When involving a serous membrane, such as the pleura, peritoneum, or synovial membrane, it gives rise to a layer of plastic lymph, which may organize into adhesions, it is also seen in the alveoli of the lungs in lobar pneumonia. On mucous membranes, such as the conjunctiva or that of the pharynx, it occasionally forms white, flaky masses, which can be readily detached, leaving an injected surface below, with merely one or more oozing points, and no loss of substance.

A **Diphtheritic** inflammation is, properly speaking, one that is due to the action of the diphtheria bacillus on a free surface. The term is, however, often applied to inflammatory processes due to other causes, but resulting in a 'false membrane' of similar nature. This differs from the false membrane of croupous inflammation in that it is formed, in part at least, by necrosed tissues, and not simply by fibrin deposited on the surface. Hence it is more difficult to 'peel off,' and when this is done a raw bleeding surface is left.

The term **Phlegmonous** is now but rarely employed. It was formerly applied to any inflammation of the subcutaneous connective tissues where the local phenomena tended to spread, and there was well-marked inflammatory swelling.

**Parenchymatous** and **Interstitial** are terms which indicate that in an inflamed organ or gland the process is mainly limited, either to the actual and active substance of the organ, or to the supporting fibrous tissue.

The term **Metastasis** was formerly employed to indicate a sudden transference of an inflammatory attack from one place to another without apparent cause. Increased knowledge of pathology has explained away almost all the formerly-described illustrations of metastasis, and, indeed, the use of this term is now almost limited to the inflammation of testis, ovary, or breast which follows mumps. It is often incorrectly applied to the secondary abscesses of pyæmia and to the secondary deposits of malignant disease, both of which are of embolic origin.

### Treatment of Acute Inflammation

It is only possible to deal here with the general principles which guide us in the treatment of inflammatory affections. The method of application of these to different parts of the body will be described hereafter.

The Local Treatment may be indicated under four headings

1 *Remove the exciting cause*, if evident, and any contributory causes when feasible. This is not a difficult matter when the lesion is a gross one, and the exciting cause tangible—e.g., a foreign body embedded in the conjunctiva or cornea, or a piece of dead bone lying at the bottom of a sinus. In a few cases, due to bacterial invasion, it may be practicable to totally excise a local focus—e.g., a malignant pustule—whilst in others, such as a carbuncle, one can scrape away the sloughy and infiltrated tissue with a Volkmann's spoon and apply powerful antiseptics, such as liquefied carbolic acid or peroxide of hydrogen. In the majority of cases, however, all one can do is to relieve inflammatory tension, as by a free incision, thereby eliminating bacteria and toxins, and then build up the local and general resisting power of the tissues, so as to allow their natural reparative activities to assert themselves.

2 *Keep the inflamed part at rest*. Wherever inflammation exists, both physical and physiological rest should be obtained as far as possible. Thus, an inflamed joint is immobilized by a splint, an inflamed mamma needs both support and the fixation of the arm, whilst if in a condition of physiological activity this must be checked by suitable treatment, an inflamed cornea requires the application of a pad and bandage to prevent the friction of the eyelid, an inflamed retina must be given physiological rest by exclusion of the light.

3 *Reduce the local blood-pressure* and hyperæmia, and thus diminish both exudation and pain. It may be pointed out here that although both hyperæmia and exudation are beneficial, yet they are almost always present in excess, and it becomes needful to keep them under control. *Elevation* of an inflamed limb may secure this end, and is a most essential element in the treatment of all inflammatory conditions of the leg, for it is a well-known fact that emptying the veins by gravity in an elevated limb leads to reflex contraction of the arteries. *Local blood-letting* by leeches, punctures, scarification, and wet or dry cupping, is useful in suitable cases, and sometimes gives immediate relief. It may be as well to mention that a leech can withdraw about 2 to 4 drachms of blood, and that it should not be applied over a large subcutaneous vein, or to parts, like the scrotum or eyelids, where there is much subcutaneous tissue of a loose texture, in which extravasation readily occurs. The bleeding from a leech-bite usually ceases spontaneously, but may require the application of slight pressure.

In diffuse inflammation of the cellulitic type *free incisions* are beneficial, partly on account of the relief of tension and pain which follows the escape of blood and retained discharges from the tissues, but also because it determines a free flow of blood serum, and as this possesses antitoxic and germicidal properties, it assists in bringing the inflammatory process to an end.

Cold wisely utilized is of the greatest service in combating inflammation, causing contraction of the arterioles, and so reducing

the hyperæmia. It should only be used *in the early stages*, and never when suppuration is threatening, as, although it may cause local depletion of the bloodvessels, it at the same time depresses the vitality of the part, and so may do more harm than good. Again, it should be used with the greatest care in old people, from fear of causing necrosis of the skin. There are various methods of applying it, as by means of an ice-bag, or by irrigation from a vessel, suspended over the part, containing iced water or lotion, from which strips of lint descend to envelop the inflamed area, or a piece of lint wrung out of evaporating lotion may be placed directly on the part, or, better still, the iced water may be run through a coil of leaden pipes (known as Leiter's tubes), fitted carefully to the inflamed region. Under any circumstances the cold must be continuous, and not intermittent, as otherwise the alternating periods of anæmia and hyperæmia will have a baneful rather than a beneficial influence.

*Heat*, especially when combined with moisture, is very largely used in treating inflammatory affections, and acts in a diametrically opposite way to cold by relaxing the vessels and tissues, thus reducing the tension and pain, it also favours the activity and vitality of the part by increasing the vascular supply and facilitating lymphatic absorption. When suppuration is threatening, the application of warmth and moisture hastens the process. For subcutaneous lesions, fomentations, medicated or not with opium or belladonna, or spongiopiline wrung out of hot water, or simply dry heated cotton wool, may be employed. When an abscess is forming, nothing can be more soothing and satisfactory than a linseed-meal poultice, provided that the abscess is not allowed to burst into it. Poultices should never be applied to an open wound or abscess, unless the latter is in a very septic condition, and then they can be rendered more or less aseptic by making them with hot carbolic lotion (1 in 40). For a very foul wound a charcoal poultice is as good an application as anything. It is made of equal parts of charcoal and linseed, and applied after dusting the wound with iodoform. The boracic poultice or fomentation is most useful in many superficial inflammatory affections due to sepsis, dirt, and want of attention. It consists of a good-sized portion of boracic lint wrung out of a hot boric acid solution (1 in 20) or hot water, and covered with oiled silk or guttapercha tissue.

4. *Prevent the access of fresh sources of irritation or infection*, such as those due to putrefactive changes in an open discharging wound.

The **General Treatment** of inflammation varies considerably with the condition of the patient, and as to whether he is strong and healthy, or weakly. Those who are depressed in health, or who may be expected readily to become so from a continuance of the febrile state, need to be carefully supported by a tonic plan of treatment, whilst at the same time attention must be directed to the elimination of toxic bodies by suitable purgatives, diaphoretics, and diuretics. Quinine may be given with great benefit, as also diffusible

stimulants, such as ether or carbonate of ammonia, whilst the recovery of patients lying in a typhoid state of exhaustion will absolutely depend on the administration at short intervals of nourishing fluids, combined with stimulants. In the sthenic type of inflammatory fever, 'antiphlogistic' means may be freely employed so as to reduce the general blood-pressure and remove irritating matters from the system, *e g*, a smart purge, followed by low diet and abstinence from alcohol for a few days, but in other instances where the blood-tension is high, as indicated by a large and full pulse, and the local signs (pain, etc.) are well marked, it may be also necessary to administer such drugs as antimony, aconite, full doses of acetate of ammonia, colchicum or ipecacuanha, in order to reduce the general blood-pressure, as also to obtain diaphoretic action. In a few cases, *e g*, acute meningitis, venesection may be needed, and it is possible that this is an agent too little employed in the present day. In some forms of inflammation due to the specific diatheses, suitable drugs must be employed to combat such tendencies—*e g*, salicylate of soda or salicin in acute rheumatism.

In inflammation of infective origin **serotherapy** may be found of use, but at present the only surgical affections in which this is generally applicable are erysipelas and a few other conditions due to streptococci, diphtheria, and tetanus.

### Chronic Inflammation

The phenomena of chronic inflammation are essentially the same as those of the acute process, though the manifestations are somewhat different. Hyperæmia and exudation occur, but the tissue reaction is much more prominent. The main differences between the two are as follows:

- 1 The hyperæmia is less in amount, but longer in duration, owing to the fact that the causative irritant is less intense in action, although often applied for a longer time. The local manifestations therefore are less obvious, pain is not so great and mainly of an aching character, whilst there is less heat, the redness is more dusky, and the tissues often become pigmented. Considerable loss of tone in the vessels, especially the veins, results from their prolonged distension, and thus there is greater difficulty in restoring them to a normal state.

- 2 The corpuscles do not adhere together or run into rouleaux to the same extent as in acute inflammation, and migration, though it exists, is on a limited scale. The exudation is more fluid in character, containing comparatively little albumen or fibrin, in fact, in some chronic inflammations of serous membranes the cavities are distended with fluid of a much lower specific gravity than that of blood serum.

- 3 The greatest difference between the acute and chronic processes lies in the reaction of the tissues. In acute inflammation, increased proliferation of the tissues is rarely a marked feature, since the toxin

has usually sufficient power to destroy their vitality. In chronic inflammations this is not the case at least not until the later stages of lesions like those of tuberculosis or syphilis. In most cases cell-proliferation is well marked, especially in the endothelial cells of the vessels and lymph-clefts, or the secreting cells of the breast, whilst others (such as the cells of the central nervous system) never undergo proliferation. These newly formed cells usually develop into fibrous tissue, but sometimes produce structures more or less resembling normal tissues. Organization, or fibroid thickening, therefore, is a marked feature of chronic inflammation.

An area which is in a state of chronic inflammation is infiltrated with large numbers of lymphocytes, which are often grouped in especially large numbers round the smaller vessels. In the conditions known as the chronic granulomata, and perhaps specially in the gummata met with in syphilis, this small round-celled infiltration is very marked, large areas composed entirely of lymphocytes being met with. Another cell which is very characteristic of these lesions, and which has recently attracted much attention, is the plasma-cell. It is much larger than a lymphocyte, and usually of an oval shape, the nucleus is about as large as that of a lymphocyte, is usually divided into five or six segments, and is placed eccentrically in the cell. The protoplasm has peculiar staining affinities. These cells sometimes occur in chronic inflammatory lesions in great numbers, scarcely another form of cell being seen in areas of considerable size, but usually they are mixed with lymphocytes.

The **Causes** are similar in character to those producing the acute mischief, but slighter and more prolonged in their action. The most striking point in the ætiology is the large part played by diathetic conditions or constitutional predispositions. Most of the manifestations met with in surgical practice are due to syphilis, tubercle, gout or rheumatism, and one should never treat cases of this nature without carefully inquiring as to the possible existence of some such taint.

The **Results** vary according to the part of the body affected, and also with the predisposing diathetic state, and we can here only indicate a few points worthy of notice.

In **Simple** chronic inflammation, not due to tubercle or syphilis, the part becomes infiltrated and enlarged, mainly from proliferation of the connective tissues, and if allowed to persist, this will result in fibrosis or sclerosis. Thus, a bone is thickened and condensed in chronic osteitis (*osteo-sclerosis*), whilst in chronic periostitis a new subperiosteal formation of bone may occur. Glands become enlarged and indurated, mainly by hyperplasia of the connective tissue, whilst if the skin is involved it either becomes hypertrophied and thickened, or entirely loses its characteristic structure, being converted into granulation or fibro-cicatrical tissue, with or without an intervening ulcerative stage. True suppuration rarely occurs, although certain organisms of low virulence occasionally lead to its development.

**Constitutional** symptoms are but little evident, beyond those

dependent on the diathetic condition to which the local phenomena are due, or to septic changes developed secondarily

The Treatment of chronic inflammation is usually more prolonged and difficult than that of acute cases, because of the constitutional dyscrasia which exists so frequently behind it

1 *The cause must be removed* whenever possible Dead or diseased bone must be removed, and tuberculous material got rid of by the knife or sharp spoon, whilst it is often desirable to supplement this by subsequently swabbing the parts over with liquefied carbolic acid A chronic abscess increases the action of the original irritant through the tension engendered by its presence, and hence it should be dealt with as early as possible

2 *Keep the part at rest* This is just as much an essential as in the treatment of acute inflammation Joints should be immobilized, the spine must have the weight taken from it by suitable appliances, or, better still, by maintaining the recumbent position, secretory glands are not actively exercised, and the organs of sense are protected from irritation

3 *Counter-irritation* is one of the most useful forms of treatment for chronic inflammatory conditions It is applied in many different ways, according to the character of the disease and the part involved Thus, *friction* with the hand, or with stimulating embrocations, produces a hyperæmic condition of the skin, and promotes local activity in the superficial parts which may react beneficially on deeper structures *Scott's dressing* may be similarly employed, it consists in wrapping up the part (e.g., a joint) in strips of lint covered with ung. hydrarg. co (containing over 10 per cent of camphor), and then encircling it firmly with soap plaster, spread preferably on chamois leather *Iodine paint* is another useful application, whilst *blisters* are most valuable in suitable cases The *moxa*, a wound produced by burning a spirituous solution of saltpetre on the skin, the *issue*, the maintenance of a raw surface, however produced, by the constant presence of some irritant, such as the insertion of a bead, or the use of savin ointment as a dressing, and the *seton*, a double thread knotted at each end, passed for some distance under the skin, and drawn from end to end daily—all these are but little used now, although they might be occasionally employed with advantage The *actual cautery* is the most severe form of counter-irritant, and is especially useful in some varieties of chronic inflammation of bones and joints

4 *Pressure* is an important element in the treatment of chronic inflammatory disorders, and probably acts by artificially bracing up vessels which have become relaxed and atonic from the prolonged distension to which they have been subjected It also favours the absorption of inflammatory exudations Firm bandaging, and especially the use of an elastic support, are the usual methods of application

5 A most valuable means of treating certain chronic inflammations, and indeed many other affections, consists in *Massage* It is impossible

in a text-book of this size to give a full account of the methods employed, but we may state that the chief of them are known as effleurage, pétrissage, and tapotement. *Effleurage* consists in plain up and down rubbing of the limb with the flat of the hand, the up stroke being always firmer than the down, so as to assist in the return of the blood and lymph from the part. In this way the circulation is quickened, and the vital activities of the tissues are increased. The skin should be lubricated with oil, vaseline, or some stimulating embrocation, and the rubbing, at first light, so as only to affect the skin and subcutaneous tissues, should gradually become firmer so as to influence the deep structures. *Pétrissage* consists in kneading the muscles or other tissues between the finger-tips and the palm of the hand, this necessarily should be done across the muscle fibres, working from below upwards, and is especially valuable in hastening the absorption of exudations. In *Tapotement* a series of blows perpendicular to the surface is rapidly delivered by the ulnar side of the open or clenched hand, the circulation in the parts thus struck is much quickened, and when skilfully done no pain should be caused.

6 *General* or constitutional treatment must be adopted to meet the specific diatheses which are commonly associated with chronic inflammation, e.g., mercury or iodide of potash in syphilis.



## CHAPTER III.

### EXAMINATION OF THE BLOOD IN HEALTH AND DISEASE

ALTHOUGH an examination of the condition of the blood is frequently of great importance to the surgeon, a mere outline of the chief facts is all that can here be attempted

The red blood corpuscles average about 5,000,000 to the cubic millimetre in men and about 4,500,000 in women, and are readily counted by means of the Thoma-Zeiss hemocytometer or other similar instrument. The chief surgical value of such investigations arises in connection with hæmorrhage, for they enable us to determine the amount of blood lost at a surgical operation or as the result of a wound, and to trace the process of recovery. It is usually advisable to supplement the counting of the corpuscles by estimating the amount of hæmoglobin present by means of Haldane's or some other hæmoglobinometer, the result being expressed as a percentage of the normal amount. Thus, blood containing half the amount that should exist in a given bulk in a normal man is said to contain 50 per cent of hæmoglobin. It is also convenient to calculate the 'corpuscular richness' or 'colour-index,' which is done by dividing the percentage of hæmoglobin by the number of corpuscles expressed as a percentage of the normal. For example, under normal conditions the hæmoglobin is 100 per cent, and there are 5,000,000 corpuscles per cubic millimetre, so that the colour-index is  $\frac{100}{5000} = 1$ . If the corpuscles have fallen to 3,000,000 (60 per cent of the normal), whilst the hæmoglobin has fallen to 30 per cent, the colour-index is  $\frac{30}{60} = 0.5$ —that is to say, each red corpuscle contains only half as much hæmoglobin as it should do. In general a high colour-index is indicative of pernicious anæmia, and one which is greatly reduced of chlorosis, though in cases of severe secondary anæmia of long standing a similar reduction may be present.

If the blood is examined immediately *after* a patient has suffered from a severe hæmorrhage, it will naturally be found to be normal in composition, part has been lost, but the quality of the remainder has not altered. After a short time the volume of blood is restored to normal by means of fluid derived from the tissues. At this stage the blood is more diluted than normal, the red corpuscles and

hæmoglobin being alike reduced, so that the colour-index remains 1. There is also in most cases a temporary increase in the number of leucocytes. The process of absorption of fluid from the tissues is imitated artificially in the infusion of saline solutions in collapse or after severe hæmorrhage, and it is found that this process has a beneficial effect in accelerating the subsequent regeneration of the blood as well as in raising the blood-pressure and removing the urgent symptoms.

In the subsequent process of recovery the red corpuscles increase more rapidly than the hæmoglobin, so that the colour-index falls somewhat. The length of time necessary for full regeneration of the blood varies greatly, the process being more rapid in men than women, and in young adults than in the old or young. Approximately 1 per cent of hæmoglobin is regenerated per diem, thus the blood becomes normal about twenty days after the loss of 20 per cent of hæmoglobin if the patient is kept under favourable conditions.

It is not possible to lay down any definite rule as to the amount of hæmorrhage which is necessarily fatal. Other things being equal, a patient will survive a much greater loss of blood if it takes place gradually than if it takes place quickly. In the latter case a reduction of the hæmoglobin to 50 per cent will probably be fatal, whereas in the former it may fall to 20 per cent, or lower, and recovery still take place. Women tolerate loss of blood better than men, and men tolerate it better than children.

Anæmic patients are usually bad subjects for operations, but it is not possible to formulate any rule for the guidance of the surgeon as to the degree of anæmia which should make him unwilling to operate.

It is important to notice that a high degree of anæmia occurs in acute spreading inflammation, septic fever, septicæmia, etc., and this fact is occasionally of diagnostic value. The diminution of the corpuscles and hæmoglobin usually occurs rapidly, sometimes with a rapidity only second to that which occurs after severe hæmorrhage, and gives rise to a severe form of secondary anæmia. The colour-index is usually low, the hæmoglobin being destroyed more rapidly than the corpuscles.

The estimation of the amount of hæmoglobin is often useful in the diagnosis of syphilis (Justus's method). In the secondary stage of this disease the red corpuscles are extremely susceptible to the action of mercury, and are readily destroyed thereby. In practice the amount of hæmoglobin is estimated, and the patient given a single dose of mercury, either as an intravenous injection or as an inunction or fumigation. After twenty-four hours the hæmoglobin is estimated again, and in positive cases it will be found to have fallen 10 to 15 per cent, or even more. In a few days the hæmoglobin will have regained its normal level, and if the dose of mercury is repeated, a second fall, not so great as in the first case, will ensue. The reaction occurs in all stages after the formation of the primary

bubo, as well as in hereditary syphilis in the latter case it is often extremely well marked and of great value in diagnosis. It is sometimes present in anæmic patients who are not the subject of syphilis, and it is advisable not to place much reliance on a reaction obtained in a patient whose hæmoglobin to begin with is much below normal. It is useless in patients who are already under the influence of mercury.

The examination of the leucocytes is often of the greatest importance. It comprises an enumeration of the total number present per cubic millimetre, and a differential count of the relative number of the various kinds present. The former examination is carried out by a method similar to that used in counting the red corpuscles, and, as it takes but a few minutes and requires but little practice, should be learnt by all surgeons. The differential count is made on thin films of blood, which are dried and stained by a double or triple stain, Jenner's stain being the simplest and most useful.

Jenner's stain consists of a solution of eosinate of methylene blue in methyl alcohol. To use it the blood film is allowed to dry spontaneously and is then flooded with the stain, which is allowed to act for about two minutes. It is then poured off, and the film is rinsed in distilled water for a few seconds, drained, allowed to dry spontaneously, and mounted in Canada balsam. This is then examined under a  $\frac{1}{2}$ -in. lens, each leucocyte seen being noted down, until 400 or more have been counted. The results are reduced to percentages.

In health the blood contains from 4,000 to 10,000 leucocytes per cubic millimetre, five different forms of cell being present—the polynuclear leucocyte, the eosinophile leucocyte, the mast-cell, the lymphocyte, and the hyaline cell. Of these, the first three contain definite granules in their protoplasm, the others do not. In the following description we assume that the film has been stained by Jenner's method. If other staining processes are used, the colours of the various structures will naturally be somewhat different.

1 The *polynuclear* or *polymorphonuclear leucocyte* (Fig 3, c) is rather larger than a red corpuscle. It is characterized by having a twisted or indented nucleus, which in badly-prepared specimens may appear to be multiple, although with proper preparation and the use of high powers of the microscope the connecting filaments between the various parts can always be made out. It contains in its protoplasm numerous very minute granules which have an affinity for acid stains, and hence are coloured pink by the eosin in Jenner's stain. In specimens which have not been well stained these granules may not be visible, but the cell can always be identified by its nucleus.

The polynuclear leucocytes are the chief phagocytic cells of the blood, being actively amœboid and endowed with the power of ingesting bacteria or other small objects. They are formed, mainly or entirely, in the bone marrow, and constitute in health from 65 to 75 per cent. of all the leucocytes.

2 The *eosinophile leucocytes* (Fig 3, d) are about as large as the

foregoing, and have a bilobed or polymorphous nucleus. They have also granules which stain with eosin, but these are much larger and more defined than those of the polynuclears.

The eosinophiles form 2 to 4 per cent of the leucocytes of normal blood. They are probably formed partly in the bone marrow and partly in other connective tissues. They are feebly mobile, and their functions are not definitely known.

3 The *mast-cells* (Fig 3, *e*) have lobed nuclei and granules which stain with methylene blue, though usually metachromatically, taking a purplish colour. They are present in very small proportions (about  $\frac{1}{2}$  per cent) in normal blood, and their functions are unknown. They are connective-tissue cells, and are often present in considerable numbers in inflamed tissues.

4 The *lymphocytes* (Fig 3, *a*) are devoid of granules, and their nuclei are not polymorphous. They vary in size, but the majority are rather smaller than the red corpuscles. Each lymphocyte has a single circular nucleus which is situated centrally, this is surrounded by a narrow zone of protoplasm, which in suitably-stained specimens takes the methylene blue more deeply than does the nucleus itself.

Lymphocytes constitute 20 to 25 per cent of the leucocytes of health. In children the proportion may be much higher, the polynuclears being correspondingly reduced. They are formed in the lymphatic glands, spleen, Peyer's patches, and lymph-adenoid tissue generally. They are probably identical with the 'small round cell' which is so characteristic of non-suppurative inflammatory foci, and in these lesions we have reason to believe that they can be produced locally, probably by a process of budding from the endothelial cells. It would seem, therefore, that lymphocytes may be produced locally in any part of the body.

5 The *large hyaline or large mononuclear cells* (Fig 3, *b*) vary in size, but as a rule are decidedly larger than the red corpuscles. They have a single circular, oval, or kidney-shaped nucleus, which is smaller relatively to the cell than the nucleus of the lymphocyte. The protoplasm stains faintly with methylene blue. It is devoid of granules, but often shows bluish points, which are really nodal thickenings of the reticulum.

These cells form 2 to 4 per cent of the leucocytes of normal blood. They have considerable powers of phagocytosis. Their

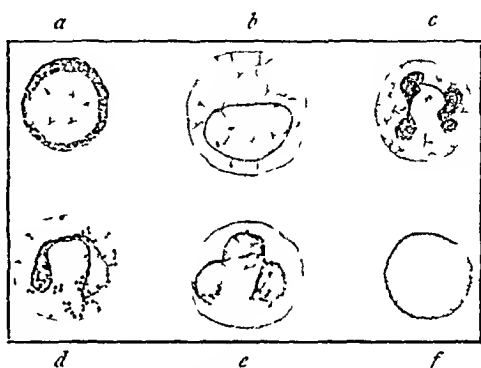


FIG 3 — CORPUSCULAR ELEMENTS OF NORMAL BLOOD (EMERY)

*a*, Lymphocyte *b*, hyaline or large mononuclear cell, *c*, polynuclear leucocyte, *d*, eosinophile cell, *e*, mast cell *f*, red corpuscle, to show the relative sizes of the other cells

origin and relation to the lymphocytes is not definitely known, but there is some reason for regarding them as endothelial cells which have been detached from the walls of the vessels

An increase of the total leucocytes present in the blood is termed *leucocytosis*. Under most circumstances this increase is mainly due to an increase in the number of polynuclears present, special terms are used for an increase of other forms of leucocytes. An increase in the eosinophiles is called *eosinophilia*, and an increase in the lymphocytes is called *lymphocytosis*. A diminution of the leucocytes is termed *leucopenia*.

*Leucocytosis* occurs under *physiological* conditions during digestion, during pregnancy, and in the new-born infant. This has to be remembered in interpreting leucocyte counts in disease. The former factor is of especial importance, and if possible the blood should be collected whilst the patient is fasting.

*Pathological leucocytosis* occurs in many conditions, the most important being the infective diseases, and in these the highest counts are met with in pneumonia and in *suppuration*. The latter is of special importance to the surgeon, as the presence of a high leucocytosis may be regarded as the most definite single sign of the presence of pus. It is especially valuable in appendicitis, where the other evidences of suppuration are often equivocal. When no pus is present, the blood shows slight leucocytosis, the number not usually exceeding 15,000 per cubic millimetre. When pus is present the number is much greater, being usually not less than 18,000, and it may rise as high as 50,000, or even higher. For practical purposes a count of 20,000 leucocytes per cubic millimetre may be taken as an almost certain proof of suppuration, presuming, of course, that the other causes of leucocytosis can be excluded. Figures between 15,000 and 20,000 are not sufficiently definite to be of much value, and where they are obtained it is advisable to repeat the examination in twenty-four hours. If suppuration is taking place the count will almost certainly rise, whilst if it remains at the same level, or shows a decline, the presence of pus is unlikely. The height of the leucocytosis gives no indication of the size of the abscess or of the rapidity of its spread.

The opening of the abscess is usually followed by a fall in the number of leucocytes, and this is so rapid as to be quite definite in the course of twelve hours. When it does not take place, the probability is that a second abscess is present, which was overlooked at the time of the operation.

The absence of leucocytosis is presumptive evidence that suppuration has not occurred, but several facts have to be considered in applying this rule in actual practice.

1. The cause of the leucocytosis is the passage of the bacterial products from the inflammatory focus to the blood-stream, where they exert a positively chemotactic action, attracting the leucocytes from the bone-marrow, whilst at the same time they stimulate the latter to an increased production of leucocytes. As long as the

abscess remains unopened and is spreading, these substances gain access to the blood-stream with ease, for it is the only path available to them. But when the abscess is opened so that the pus laden with bacterial toxins can drain away, the leucocytosis falls, even although the abscess may burrow for a time. An example of this was seen in a patient suffering from appendicitis, in whom there were very doubtful clinical indications of pus, and who showed a leucocytosis of 38,000, this was regarded as definite proof of the existence of an abscess. A few hours after the count was made the patient suffered from diarrhoea, and pus was found in the stools. A second count was made forty-eight hours after the first, and the leucocytes were found to have fallen to 13,500, yet at the operation a large abscess cavity with extensive ramifications was found. If the patient had been admitted to the hospital after the rupture of the abscess into the intestine, the leucocyte count would have led to an erroneous conclusion. For a similar reason—viz, the non-absorption of toxins into the blood—there is but slight leucocytosis in suppurative inflammation of the mucous membranes.

2 When the pyogenic bacteria have been killed, the toxins are soon carried away in the blood-stream and eliminated from the body, and when this has happened the leucocytosis falls, although there is still a collection of pus in the tissues. In other words, a high leucocytosis is to be regarded rather as a proof of the process of suppuration than as a proof of the presence of pus. For example, such sterile collections of unabsorbed pus often occur in cases of pyosalpinx of some standing, and are unaccompanied by leucocytosis, although acute suppuration in the Fallopian tubes causes the usual reaction.

3 When the organisms are very virulent and the patient of feeble constitution, so that the infection rapidly spreads, there is often a failure of leucocytosis or even a leucopenia. This is notably the case in severe cases of diffuse septic peritonitis. The general (as well as the local) leucocytosis must be regarded as a conservative and defensive reaction, whatever views are held as to the nature of immunity. Its presence indicates that the patient has sufficient resisting powers to combat the infection, or at least to localize it for a time, its absence in a case where there is suppuration renders the prognosis unusually bad.

4 Leucocytosis does not occur in cases of chronic or cold abscess. The products formed by the bacteria which produce these lesions have no positive chemotactic action on the polynuclear leucocytes. The cells found in the local lesions are mostly lymphocytes. Hence, even when the toxins of these organisms enter the blood, they fail to attract the polynuclear leucocytes from the marrow. We might reasonably expect that an increase in the lymphocytes would occur, but these cells are not actively motile like the polynuclears, and are not so readily subservient to chemotactic influences.

Another method sometimes used in the diagnosis of suppuration is based on the appearance of granules of glycogen (or an allied

substance) in the protoplasm of the leucocytes in septic diseases. Dry blood films are mounted in a solution of iodine 1, iodide of potassium 3, water 100, which has been saturated with powdered gum acacia. This stains the granules deep brown. This test is not as useful as the foregoing.

The relations of some of the other infective diseases to the leucocytes may be briefly epitomized. In pneumonia, erysipelas, diphtheria, scarlet fever, plague, and whooping cough there is a high leucocytosis, the number rarely falling below 20,000. In rheumatic fever (uncomplicated), syphilis, and gonorrhœa there is usually a slight rise, and in tuberculosis, typhoid fever, influenza, measles, and malaria there is usually no excess, and often a diminution, in the number of leucocytes (leucopenia).

Pathological leucocytosis also occurs after severe hæmorrhage, and in all cachectic conditions, especially in that due to malignant disease. In these cases it is almost always due to a local inflammation excited by the new growth, and is rarely of diagnostic value. In carcinoma of the stomach there is usually an absence of digestion leucocytosis, and this fact may assist in the diagnosis. The leucocytes are counted whilst the patient is fasting, and two or three times (at intervals of an hour) after a meal, which should include some meat. If the count does not rise considerably (2,000 per cubic millimetre or more), it affords strong presumptive evidence of the presence of malignant disease of the stomach, but, like all laboratory tests, must be considered in conjunction with the clinical phenomena.

**Lymphocytosis**, or an increase of the lymphocytes, may be absolute or relative. A relative increase (*i.e.*, such that the percentage of these cells rises above 25, although the total number of leucocytes of all sorts does not exceed the normal) occurs in typhoid fever, tuberculosis, and malaria. A great excess of leucocytes (150,000 or more per cubic millimetre), the great majority being lymphocytes, occurs only in lymphatic leucocythæmia, and constitutes an important means of diagnosis between this condition and Hodgkin's disease, in which the leucocytes are normal or but slightly increased. Children's blood contains an excess of lymphocytes, reaching 60 per cent, and in inflammatory diseases of children the increase in the total leucocytes may be due partly to an excess of lymphocytes, and not only of the polynuclears, as in the adult. This is especially the case if the lymph-glands are involved in the inflammatory process.

**Eosinophilia**, *i.e.*, a relative increase of the eosinophiles, occurs in several conditions. (1) In infection with animal parasites, especially in trichinosis, where the proportion may be 60 per cent or more. They are sometimes increased in hydatid disease, in doubtful cases this fact has some diagnostic value, but a count in which there is no increase is of little importance. (2) In skin diseases, especially when a large area of skin is involved. (3) In asthma. (4) In gonorrhœa, and a few other diseases.

A brief account of the blood conditions in those diseases which are especially connected with the blood-forming organs may be of some value

1 In *pernicious anæmia* the corpuscles are greatly reduced in numbers, whilst the hæmoglobin is reduced, but to a lesser extent, the colour-index being greater than 1. A typical case had 800,000 red corpuscles and 20 per cent of hæmoglobin, the colour-index being 1.2. The red corpuscles are often distorted in shape (poikilocytosis), and large (*megalocytes*) or small (*microcytes*) forms occur. Large nucleated red corpuscles (*megaloblasts*) are usually present, and are almost diagnostic of the disease. The leucocytes are usually normal or subnormal in number, and there is a relative increase of lymphocytes.

2 In *chlorosis* the hæmoglobin is reduced to a greater extent than the corpuscles, the colour-index being less than 1. A typical count gave—red corpuscles, 4,000,000; hæmoglobin, 40 per cent; colour-index, 0.5. There may be some microcytes, but the red corpuscles are usually normal in shape and size, though of pale colour. The leucocytes are usually normal.

3 In *spleno-medullary leucocythæmia* there is an enormous increase in the leucocytes, the number is usually not less than 100,000 per cubic millimetre and may rise to 1,000,000 or even more. Of these a large proportion are myelocytes, cells which do not occur in normal blood. They vary in size, but are usually large, and may be very large, they have a single nucleus, which stains badly and is circular, oval, or indented, and often excentrically placed, they contain granules similar to those of the polynuclear leucocytes. The eosinophile cells are greatly increased in absolute numbers, though their proportion relatively to the other cells may be normal. Eosinophile myelocytes also occur, they are similar in all respects to the myelocytes, except that their granules are large, resembling those of the eosinophiles of normal blood. The polynuclears are present in vast numbers, but their relative proportion is less owing to the number of the myelocytes. The lymphocytes are scanty, but the mast-cells are often abnormally plentiful. Nucleated red corpuscles occur.

4 *Lymphatic leucocythæmia* can be distinguished from Hodgkin's disease (lymphadenoma) only by an examination of the blood. In the former disease there is a vast number of leucocytes, the great majority (90 per cent or more) of which are lymphocytes. In the early stages of Hodgkin's disease the blood is absolutely normal, whilst later there is marked anæmia. The leucocytes are not usually increased in numbers, and there may be leucopenia, there is often a slight relative increase in the lymphocytes. In some cases there is leucocytosis. Hodgkin's disease cannot be differentiated from tuberculosis of the lymphatic glands by a blood count alone.

The examination of the blood for parasites (including bacteria) is often necessary. It may be carried out by microscopic examinations of



fresh blood or blood-films, or by cultures, the method to be selected must depend upon the organism sought

The diagnosis of *malaria* may be made by an examination of a wet film of fresh blood made by taking a small drop of the blood on a perfectly clean cover glass and allowing it to fall on a perfectly clean slide, or films may be prepared in the ordinary way and stained by carbol-thionin, hæmatoxylin and eosin, Jenner's stain, or by other methods. For a description of the organisms and their life-history the reader is referred to special treatises

*Relapsing fever* is due to a corkscrew like organism (the *Spirillum Obermeyerii*), which is about two or three times as long as the diameter of a red corpuscle. They may be demonstrated by the method used for the malaria parasite, and in fresh specimens are as a rule actively motile

The diagnosis of *filariasis* is best made by examining with a low-power lens thick layers of fresh blood taken at night, if *F. nocturna* is suspected, in the daytime, in the case of *F. diurna*, and at any time if *F. perstans* is sought

Where bacteria are sought for in the blood, cultural methods are almost always necessary, for their numbers are usually so small that the chance of finding even a single specimen in a stained blood-film is remote. The blood must be drawn directly from a vein with a sterilized hypodermic needle and syringe (or better with a hypodermic needle mounted on a short length of glass tubing and the whole sterilized by heat), and full precautions must be taken in sterilizing the skin. At least 3 or 4 c.c. should be taken and inoculated directly into broth or melted agar, which is incubated and examined at the end of twenty-four and forty-eight hours. It is worse than useless to attempt to make a bacteriological examination of blood obtained from a skin puncture, however carefully the skin may have been sterilized

In septicæmia, pyæmia, ulcerative endocarditis, and other diseases due to the pyogenic bacteria, the organisms may or may not be found in the blood. A positive result is most likely to be obtained in severe cases, especially when the blood is collected during a rigor, it is of evil omen, although such cases are by no means necessarily fatal. Cultures in which staphylococci are the only organisms to develop must be interpreted with caution, as being possibly due to accidental contamination. A negative result is usually of little value in diagnosis, as organisms may be absent from the blood for long periods in cases of septicæmia

It is sometimes necessary to examine the blood for bacteria in the diagnosis of *typhoid fever*, especially when the infection is not due to the ordinary typhoid bacillus, but to one of its congeners (the paratyphoid bacillus, etc.). In general, the diagnosis is made by means of Widal's reaction

## CHAPTER IV

### NON-SPECIFIC\* PYOGENIC INFECTIONS

IN this chapter we propose to deal with a series of affections associated with or allied to suppuration, and due to non-specific bacteria. These organisms, usually termed *pyogenic*, cause an inflammatory reaction in the tissues, which sooner or later is associated with liquefaction of both tissue and exudate, the liquefied material being known as *pus*, and the process which leads to its formation as *suppuration*. Any localized collection of pus in the tissues is known as an *abscess*, and when due to pyogenic organisms it usually follows an acute course, but is occasionally chronic. Sometimes the infection involves the cellular tissue of a part in a more or less diffuse manner, the pus burrowing widely, this condition is termed *cellulitis*. Constitutional phenomena are associated with these local manifestations, and may be of two types: (a) When toxic products alone are absorbed, producing toxæmia, or some modification of the same, and (b) when the bacteria invade the blood-stream and become disseminated to distant parts, thereby giving rise either to *septicæmia* or *pyæmia*. Each of these various conditions must be dealt with separately, but one must first describe in some little detail the organisms common to the whole group.

**Bacteriology** — The following are the more important *pyogenic bacteria*.

1 The *Staphylococcus pyogenes* is perhaps the most common organism of acute localized suppuration, especially in connection with the skin and subcutaneous tissues. It is a coccus of medium size which occurs in the pus in characteristic clusters, which have been compared to bunches of grapes (Fig. 4). It stains by Gram's method, and liquefies gelatin or solidified blood serum, as it produces a powerful peptonizing enzyme, and is readily cultivated on almost all media, it grows best when an abundant supply of oxygen is present.

Cultures on solid media develop rapidly, and the colonies spread, the surface being soon covered by a uniform thickish film of growth. This may be orange-yellow, lemon yellow, or white in colour, and three organisms — *Staphylococcus pyogenes aureus*, *citreus*, and *albus*, respectively — have been recognised. Under certain circumstances,

\* For the significance of the term *non-specific*, see p. 12

however, the one may change into the other, and there is little doubt that the three really constitute one species

Staphylococci are very widely distributed without the body, being common in air, dust, etc. They are frequently found in the human skin, though apparently not normal inhabitants of that region. Suppurative inflammations of the skin and subcutaneous tissue are due to staphylococci in the vast majority of cases, and when the inflammation is caused by other organisms in the first instance, a secondary infection with staphylococci almost always takes place later. Impetigo contagiosa, a disease due primarily to streptococci, may be taken as an example of this, and the vesicles of small pox or vaccinia another, for in each case a secondary staphylococcic invasion takes place. The chief skin lesions due to staphylococci are abscesses, boils, carbuncles, pustular acne, etc. In some cases diffuse spreading cellulitis depends on the same cause, but this is unusual. Deep-

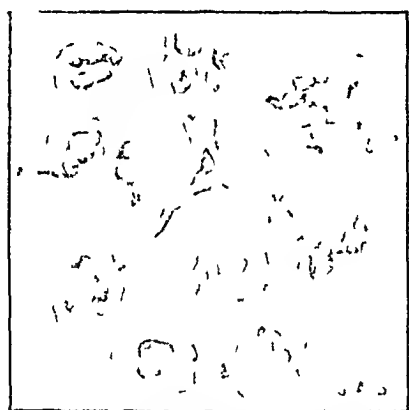


FIG 4—STAPHYLOCOCCI IN PUS  
(FROM CROOKSHANK'S 'TEXTBOOK  
OF BACTERIOLOGY')

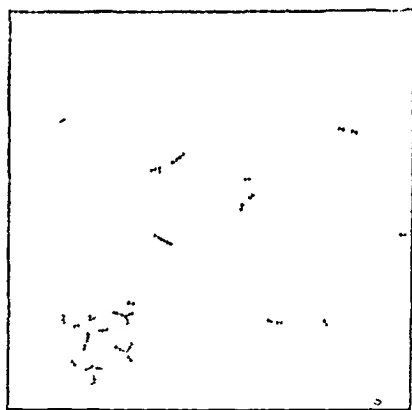


FIG 5—STREPTOCOCCI IN PUS (REDUCED FROM CROOKSHANK'S 'TEXTBOOK OF BACTERIOLOGY')

seated suppuration, such as osteomyelitis, peritonitis, empyema, etc., may also be due to staphylococci, in fact, they may cause suppuration in any part of the body. Lastly, staphylococcic septicæmia, pyæmia, or ulcerative endocarditis occurs, but is less common than the forms due to streptococci, and the prognosis appears to be slightly less grave.

Most cases of suppuration occurring after operations in which the antiseptic or aseptic precautions have been inadequate are due to staphylococci, either alone or in admixture with other organisms.

2 The *Streptococcus pyogenes* is an organism in which the individual cocci are arranged in longer or shorter chains (Fig 5). It stains with Gram, and does not grow very easily on artificial culture media. A temperature approximating to that of the body is requisite, and hence it does not grow on gelatin. The colonies are small and translucent, and do not tend to spread or become confluent. It

forms no peptonizing enzyme, and hence does not liquefy solidified blood serum. The cultures readily die out.

On comparing cultures of *Streptococcus pyogenes* from different sources, slight differences may be noted, e.g., in the length of the chains, the size of the cocci, the appearance of the colonies, etc. It is as yet uncertain whether these are sufficient to differentiate several species, or whether they merely indicate unimportant (and perhaps not permanent) varieties of a single species.

The *Streptococcus pyogenes* is, on the whole, a more virulent organism than the staphylococcus, and tends to produce an acute spreading inflammation rather than a localized abscess, although the latter lesion is quite commonly due to it. Erysipelas is due (in most cases) to a streptococcus which has been held to be a distinct species, but the differences are unimportant, and the two are generally considered identical. Cellulitis, too, is usually due to the *Streptococcus pyogenes*. Apart from this, the organism plays its most important rôle in connection with puerperal-septicæmia, of which the great majority of cases are due to its action. It is also the most common cause of septicæmia and pyæmia apart from the puerperium, and of ulcerative endocarditis.

3 The *Pneumococcus*, the cause of lobar pneumonia, is a diplococcus, the individual cocci of which have usually a triangular or lancet shape, the bases of the two cocci facing one another. When it occurs in pus or other animal fluids, it is surrounded by a clear capsule. In cultures it closely resembles the *Streptococcus pyogenes*. It is chiefly of importance in suppuration in connection with the lungs, especially empyema. It occurs almost constantly in all inflammatory lesions of the lung, whatever their origin, as a secondary infection, thus, the suppuration which takes place in the walls of a tuberculous cavity is almost always due to pneumococci alone or in conjunction with other organisms. It is a common cause of bone disease, especially in the middle ear, and of its intracranial complications. Pneumococci also cause arthritis, which may or may not result in suppuration, the arthritis usually follows an attack of pneumonia, but this is not necessarily the case.

The pneumococcus frequently enters the blood and causes septicæmia, with or without ulcerative endocarditis.

4 The *B. coli communis* is of great importance in connection with suppuration in the neighbourhood of the intestines, in the contents of which viscus it occurs in great numbers in health. It is a short motile bacillus which does not form spores, and is not stained by Gram's method. It grows best in presence of oxygen, but is a facultative anaerobe, no peptonizing enzyme is produced, so that gelatin is not liquefied. The *B. coli* is one of the most important putrefactive organisms, and it breaks down proteids, forming indol and allied bodies, and gases with fæcal odour. It is closely allied to the typhoid bacillus, and is distinguished therefrom by its action on various sugars, thus, the typhoid bacillus produces acid, but no gas, when grown in broth containing glucose, whereas

the *B coli* produces both acid and gas. These two bacteria are members of a large and important group of micro-organisms which have a close morphological resemblance to one another, but differ in their chemical activities. Of these, the most important are the bacillus of dysentery (of Shiga and others), the bacillus of Gaertner, a common cause of poisoning from stale meat, etc.

Under normal conditions the bacilli of this species, which occur in the intestinal contents, are not very virulent, but when any pathological condition arises in the gut then virulence appears to be increased, and an active invasion of the tissues may occur. Thus, the *B coli* appears as a secondary infection of almost any inflammatory lesion of the abdomen. It is a very common cause of appendicitis, acute peritonitis, etc., and pus due to its action has usually a faecal odour. It can also ascend the bile-ducts, and is the commonest cause of cholecystitis, cholangitis, etc. Lastly, the *B coli* is one of the commonest causes of cystitis. It has, however, no power to render the urine alkaline, this is due to the presence of a micrococcus, formerly known as *M ureæ*, but now believed to be identical with *M epidermidis albus*, an organism of constant occurrence in the skin.

5 The *typhoid bacillus* sometimes causes abscesses, especially in connection with the bones, after an attack of typhoid fever. In some cases the organism may lie latent for years before suppuration occurs.

6 The *B pyocyaneus* is a comparatively rare cause of suppuration. The pus which it causes turns bluish-green when exposed to the atmosphere. It sometimes gives rise to a general infection.

7 The *Gonococcus* (see p. 129)

8 The *M tetragenus*, an organism in which the individual cocci occur in tetrads, is rarely met with.

Many cases of suppuration are due to a *mixed infection* with two or more of the species of bacteria enumerated above. In other cases an abscess may be formed by the action of one of the pyogenic bacteria, and be subsequently inoculated with other species, which may be simple saprophytes that have the power to grow in the dead pus, but cannot invade the living tissues. This accident is very likely to occur in a large abscess when the drainage is insufficient and the dressings are not performed with sufficient care, it should be carefully avoided, for, as a general rule, lesions due to a mixed infection heal with difficulty, it would seem as though the tissues can more easily acquire immunity to a single organism than to two or more at the same time. The fact that a wound is already septic is not, as it is too frequently considered to be, any reason for neglecting to treat it with the fullest antiseptic or aseptic precautions.

## I Acute Abscess

**Ætiology** —(a) It may be taken as established that *suppuration* as met with in surgical practice is *always due to the action of bacteria*. It is true that in laboratory experiments on animals it is possible to obtain aseptic suppuration by the use of certain chemical irritants, such as croton oil, etc., but these conditions never occur in man. It is also true that in certain abscesses, notably in the liver and in pyosalpinx, no organisms can be found in the pus on microscopical or cultural examination. This is usually due to the fact that the pus has not been examined until the bacteria have been destroyed and the abscess has ceased to spread. In other cases the organisms may be present in very small numbers, or may not grow on the ordinary culture media, and in this connection it may be well to point out that new pathogenic bacteria are frequently being discovered.

(b) ~~That such bacteria can reach the area which becomes inflamed either from without the body or from within~~. The former method is the more usual, and is illustrated by the observations of Garré and Bockhardt, who rubbed cultures of *Staphylococcus pyogenes aureus* into the skin of their arms, and produced acute suppuration, commencing in superficial pustules, and finishing as boils or carbuncles. The *Staphylococcus pyogenes* is commonly present in the air, and is frequently deposited on the skin, instruments, dressings, etc., and it is to infection from without, due to bacteria gaining access from one or other of these sources, that the majority of cases of suppuration are due. In some cases, however, there is reason to believe that the bacteria may gain access to the tissues from the blood, and this without any obvious pre-existing disease. For instance, it sometimes happens that a deep lesion (such as a ruptured muscle or ligament) gives rise to suppuration, although the skin over it is unbroken, and the tissues between it and the abscess are apparently healthy. Here we must assume the possibility of *auto-infection*. It is true in general that the blood of a healthy animal is devoid of micro-organisms, but recent research has shown that it is not uncommon for bacteria to gain access to the vessels and lymphatics of the abdomen from the alimentary canal. In health it is probable that these organisms are soon destroyed by phagocytosis or by the bactericidal powers of the blood, but when they are deposited in an area of low vitality (such as a blood-clot) they may be sheltered from these agencies until they are able to grow, produce their toxins, and give rise to an abscess. It is probable that the organisms can exist for a longer time in the blood of a patient of lowered vitality, so that these patients are more likely to develop suppurative lesions in this way.

Some *idiopathic abscesses* may be due to organisms which have lain latent in the tissues, it may be for long periods. This is never very easy to prove, but the possibility of such latency is shown by the fact that a patient may develop leprosy many years after exposure to infection. A more common example may be seen in the bone

abscesses which sometimes develop months or years after an attack of typhoid fever, and which are due to the typhoid bacillus, though in this case we cannot exclude the possibility of a subsequent infection with the same certainty as in the case of leprosy. In what state the bacteria lie latent in the tissues and the nature of the conditions which excite them into activity are unsolved problems, we should expect the latter phenomenon to be due to general ill health or to local injury, but cases occur in which no such factors can be traced. It is probable that they would regain their activity if an operation took place in a region in which they were deposited. If this were the case the wound would suppurate, although the antiseptic precautions were perfect in every detail. A group of cases of very different nature occurs when pyogenic bacteria are carried from a suppurative lesion in one part of the body to another region, where they induce a *secondary embolic abscess*, this occurs in pyæmia, gonorrhœa, etc.

(c) *Sterilized foreign bodies* (e.g., silver wire or glass splinters) *do not produce suppuration*, except in the rarest of cases, by auto infection. Thus, a ragged splinter of glass,  $1\frac{1}{4}$  inches long and  $1\frac{1}{2}$  inches wide, the result of the bursting of a soda-water bottle, was cut out of the neck of a hotel porter ten months after it had entered, it had caused no suppuration. This fact is constantly made use of at the present day in surgical practice, deep layers of the tissues are brought together by carefully sterilized buried sutures, and divided structures such as bones, ligaments, etc., are approximated and held in position by wire, screws, pegs, and various forms of buried appliances, which would cause endless trouble but for their complete sterilisation.

In conclusion, therefore, although we have to admit that suppuration may be experimentally induced in animals in the absence of micro-organisms, *in man for all ordinary conditions suppuration does not occur apart from the presence and vital activity of specific bacteria*.

The causes of an acute abscess may for practical purposes be grouped under the three following headings: (1) The individual affected is possibly in a depressed and unhealthy state, and the germicidal properties of his tissues may be defective. (2) A local nidus must exist, which is in a condition of lowered vitality, from injury, cold, or otherwise, and (3) this spot must become infected with pyogenic organisms brought to it either from within or without the body.

**Formation and Structure of an Acute Abscess** — The bacteria which have gained access to the tissues grow and produce their toxins, and these diffuse into the surrounding structures, giving rise to acute inflammation, the vessels dilate, acceleration of the blood-stream occurs and is replaced by retardation and thrombosis, and the leucocytes emigrate. The toxins then act still more powerfully on the injured tissues and destroy their vitality, usually by a process of coagulation-necrosis. A section through the lesion at this stage will show two well-differentiated zones (Fig. 6) — a central area in which the tissues are dead, have lost their staining properties, and contain the pyogenic

bacteria, and a peripheral zone of ordinary acute inflammation, which fades gradually into the surrounding healthy tissues. The inflamed zone, as is usual, is thickly infiltrated with leucocytes, and on examination these will be found to be mainly of the polynuclear variety. This is quite characteristic of suppurative inflammation, the products of the pyogenic bacteria have special attractive (chemotactic) powers over the polynuclear leucocytes.

The central necrotic mass which contains the bacteria is at this stage still attached to the surrounding living tissue, and if the lesion



FIG 6—FORMATION OF ABSCESS IN THE KIDNEY (THOMA)

In the centre is a zoogloea mass of organisms, around it, a zone of devitalized tissue and, still further out, an infiltration of the living tissues with polynuclear leucocytes.

is incised it will appear as a small slough, which can only be removed with difficulty. But this condition soon changes: the bacteria continue to elaborate their toxins, and polynuclear leucocytes are attracted in large numbers, accompanied, of course, by the plasma exuding from the vessels. The tension in the inflammatory focus becomes so great that the cohesion of the tissues around the central slough is destroyed, and a third zone—of polynuclear leucocytes swimming in fluid—is formed between it and the inflamed outer zone. Where the toxins have a peptonizing enzyme action, it is possible that this plays some part in liquefying the tissues, but its importance is probably less than was formerly attributed to it.



The fate of the small slough varies according to circumstances. It may occasionally be recognised when a small abscess is opened—e.g., the core of a boil—but in most cases it is absorbed by the leucocytes or digested by the peptonising enzyme which many pyogenic bacteria form, and no trace remains. It may even happen that no definite slough is ever formed, the earliest effect of the bacteria being to attract the leucocytes in vast numbers into inflamed but still living tissues, which are then killed and digested cell by cell.

This collection of leucocytes suspended in plasma and surrounded by a zone of inflamed tissue constitutes an *abscess*. The leucocytes and fluid are collectively termed *pus*, and it is important to recognise that the characteristic cells of the pus from an acute abscess are the polynuclear leucocytes. These, however, differ somewhat from those seen in blood-films. Many of them are killed by the toxin (as can be seen from their loss of motion when the fresh pus is examined on a warm stage), and undergo various degenerative changes. Many of them contain bacteria.

At first the abscess often extends rapidly, but after a day or two (in most cases) a certain amount of local immunity is produced, and the abscess spreads more slowly. This is an indication of the fact that the tissues, which were at first overwhelmed by the action of the bacteria and their toxins, are now carrying on the contest on more even terms. At this period the cavity becomes lined by *granulation tissue*, which forms a thick, soft layer of velvety appearance and bright pink colour. It is composed of large numbers of loops of newly-formed bloodvessels, which are distended with blood and embedded in a mass of leucocytes and tissue cells in a state of active proliferation. These vascular loops (clothed with a layer of leucocytes, etc.) project on the surface, giving rise to the small granulations from which the tissue derives its name. Granulation tissue differs from the inflamed tissues which form the wall of an abscess which is rapidly extending, in that in the former case some attempt at repair has taken place. Its appearance does not necessarily indicate that the abscess has entirely ceased to spread, for the toxins may still be powerful enough to kill the delicate newly formed tissue cell by cell, but in most cases it is the first indication of the ultimate victory of the tissues. Leucocytes continue to pass from the thin-walled vessels of new formation into the abscess cavity, being attracted chemotactically by the substances present in the pus, hence the layer of granulation tissue appears to secrete pus, and was formerly called a pyogenic membrane. Its appearance was anxiously looked for by surgeons in the days when suppuration was considered essential for the healing of wounds, and for a very good reason. It opposes a strong barrier to the bacteria and their toxins, and in large measure prevents their entering the blood-stream. Thus the formation of thick, creamy pus of a yellowish colour, such as is produced by such a pyogenic membrane, was looked upon as a sign that the patient was practically out of danger of septic absorption. Such pus was termed 'laudable.'

Abscesses do not as a rule spread equally in all directions, since certain structures, especially bone and fascia, are more resistant than cellular tissue or fat, moreover, large collections of pus may travel downwards under the influence of gravity. The process of extension continues, the abscess becoming larger and larger, until it 'points,' and subsequently bursts through the skin or into the alimentary canal or other cavity. When this happens the conditions are changed, for the toxins formed by the bacteria are able to escape easily, and in consequence their action on the pyogenic membrane is less profound. The bacteria, too, diminish in number, since they also escape in the pus. The result of this is that the contest between the defensive powers of the tissues and the destructive powers of the bacteria, in which the latter were victorious at first, turns in favour of the tissues. The bacteria which remain are attacked with greater effect by the leucocytes, and are gradually removed, the supply of toxin gets less and less, the inflammatory process in the abscess wall becomes less severe, and finally organization of the granulation tissue commences. This is carried out by a process quite similar to that which occurs when a wound heals by 'second intention' (Chapter IX), and ultimately the granulation tissue is replaced by new connective tissue permeated by new vessels. This process begins at the bottom of the abscess cavity, the walls of the upper portions being kept apart from one another by the pus which is still secreted, though in gradually diminishing quantity. The result is that the abscess cavity becomes less and less deep, and finally heals altogether. This process is greatly facilitated if efficient drainage is provided, so that the bacteria and toxins find a ready exit, and may be hastened even more if the cavity is gently washed out now and then.

Occasionally, but rarely, the defensive powers of the body are sufficient to kill off the bacteria after pus has been formed, and before it has been evacuated. When this happens, the pus may become absorbed and the cavity gradually obliterated, or the fluid part only may be removed and the leucocytes (which undergo fatty degeneration) remain as a cheesy, structureless mass. In either case the abscess wall organizes into fibrous tissue. In the former case a deep scar is formed in the tissues, in the latter a fibrous capsule round the inspissated mass. It is rare, however, for this to happen. The fact of pus being formed in the first instance shows that the virulence of the bacteria is sufficient to kill the tissues, and when pus is once formed the organisms find a suitable pabulum for their growth, and are to a certain extent shielded from the living tissues. Hence the rule '*ubi pus, ibi evacua*'.

The **Clinical Signs and Symptoms** of an acute subcutaneous abscess may be arranged under three headings

- 1 The *local signs* consist of a patch of inflamed tissue, indicated by heat, pain, redness and swelling, which latter is at first hard and brawny, but when pus forms the centre becomes soft, elastic, and fluctuating, whilst superficial oedema is more marked, and the pain

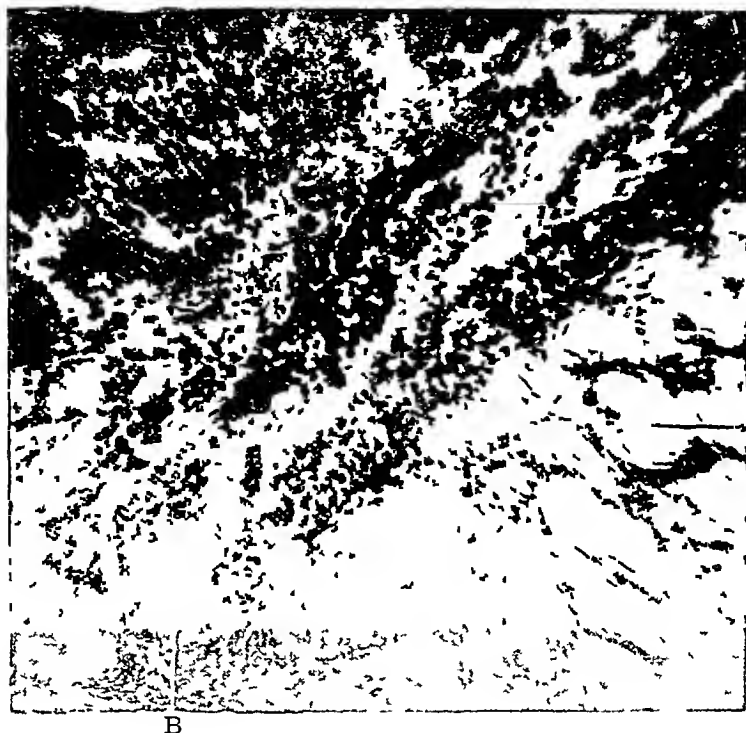
throbbing in character. Naturally, the amount of this pain depends entirely upon the density of the tissue affected and the supply of sensory nerves to the part, suppuration beneath a resisting membrane, such as the palmar fascia, being always intensely painful. If left to itself, an abscess sooner or later points and bursts. As it increases in size, it exerts pressure in all directions, and naturally seeks to find an exit in the line of least resistance, and so may either find its way to the surface, or may burrow along muscular and fascial planes, or into adjacent cavities. This is not merely a mechanical, but also a vital process, as already described. The actual bursting of an abscess is often due to some injury—it may be a slight one—but is usually preceded by ulceration of the integument, or perhaps, if the abscess is a large one, by necrosis.

2 *Pressure-effects* are mainly due to the mechanical influence of the swelling upon surrounding structures. The most evident are those due to the irritation of nerves, as a result of which neuralgic pain may be present, or the patient may refer the pain to some distant unaffected region. In some cases, where bloodvessels are involved, the tissue around them disappears, and they are left in the abscess cavity as bands, surrounded by granulation tissue. Thrombosis and the subsequent obliteration of the vessel may result, or occasionally ulceration and hæmorrhage (ulcerative periarteritis), preceded perhaps by an aneurismal dilatation of the vessel, owing to its loss of external support. Such effects are more common in chronic than in acute abscesses.

3 The *general effects* of the formation of an acute abscess are those of increased fever, sometimes amounting to a rigor, and leucocytosis. A *rigor* consists of a definite series of phenomena, the result of some stimulating influence reaching the thermogenic centres of the medulla, and determining a sudden increase of activity. It is very similar in nature to an attack of ague, being ushered in by a feeling of intense cold and discomfort, the features are pinched, and the teeth chatter. The skin, however, feels dry and hot, and the temperature of the body rapidly rises. The sensation of cold is partly due to the contact of air at a maintained normal temperature with the hot, dry, un-perspiring skin, and also possibly to the condition of superficial anæmia which is present. After this stage has lasted a variable period, the patient gradually begins to feel warmer, the face becoming flushed, the thermometer ceasing to rise, and the skin commencing to act. Finally there is a rapid fall of temperature accompanied by profuse perspiration, which leaves the patient more or less exhausted.

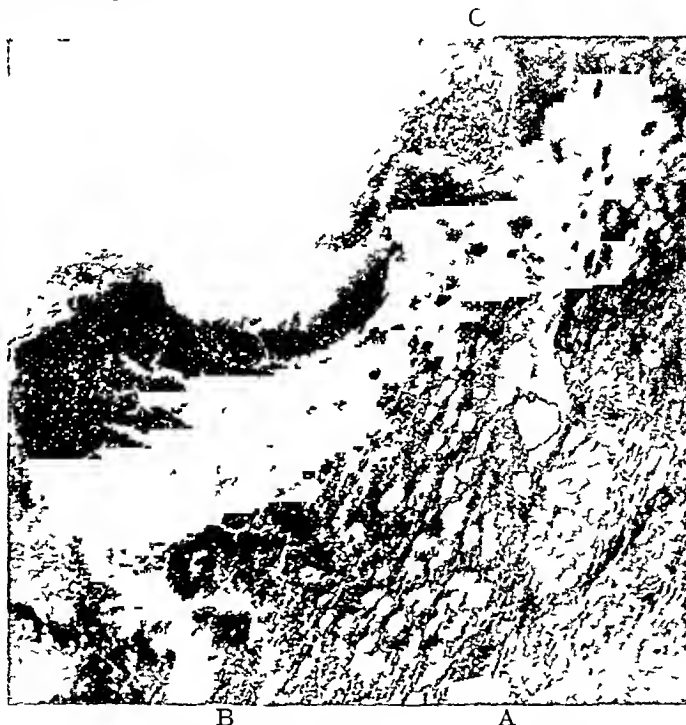
For *leucocytosis* and its value in the diagnosis of suppuration, see p 48

**Pus and its Constituents**—Normal, or as it was formerly called, healthy-or-laudable pus, is a thick, creamy fluid, having a specific gravity of about 1030, an alkaline reaction, no smell (unless putrefying or under special circumstances), and containing 85 to 90 per cent of water. If allowed to settle, it separates into two layers, an



**FIG 7 —EARLY STAGE OF ABSCESS FORMATION**

The specimen was taken from the heart of a guinea pig forty eight hours after intravenous injection of staphylococci. A, transverse section of cardiac muscle, with thrombosed vessels and polynuclear leucocytes between the fibres, B, remains of muscular fibres undergoing coagulation necrosis, C, mass of polynuclear leucocytes which have replaced the muscle tissue, and will subsequently be transformed into pus



**FIG 8.—SECTION OF ABSCESS WALL EIGHT DAYS OLD**

A, limiting zone of fibro-cicatrical tissue, with spindle shaped nuclei, B, vascular granulation tissue, with vessels cut transversely, C, superficial layer of granulations undergoing necrotic changes at the surface. A few capillaries, running perpendicular to the surface, are seen, but some of the larger spaces are due to shrinking of the specimen during its preparation. (Much less highly magnified than Fig 7)



upper or fluid part, the liquor puris, which is usually clear or slightly opalescent, and colourless, and a deposit of a yellowish-gray colour, which is usually more bulky than the fluid portion. The liquor puris is derived from the plasma exuded from the vessels. It may undergo coagulation after removal from the body, a very loose clot being formed. Frequently, however, this does not happen, perhaps because it has already coagulated within the abscess, and the resulting fibrinous network has been dissolved by the peptonizing ferment of the toxins, or destroyed by the leucocytes. It consists chemically of an albuminous fluid very similar to serum, but more dilute, and contains bacterial toxins, enzymes, proteones formed by the digestion of proteids, etc. Sometimes (when the abscess involves a region containing fat) a few globules of oil float on the surface or occur in an emulsified form in the fluid.

The solid portion consists in the main of polynuclear leucocytes, most of which, as has been already pointed out, are dead and degenerated, whilst a few are still alive and capable of spontaneous movements. In addition, there are fragments of cells and nuclei from the tissues, shreds of fibrous tissue, granular débris, and bacteria. A few red blood corpuscles are often present.

When pus is mixed with blood, it is termed sanious (short for sanguineous), when thin and acrid, it is ichorous, curdy, when mixed with curdy shreds, as is more usually seen in chronic suppuration of a tuberculous nature, mucopus, when mixed with mucus, arising from inflammatory conditions of mucous membranes.

Occasionally an abscess is found to contain not only pus, but also gas. This may be due to the existence of a direct communication with some hollow viscus—*e g*, the stomach or intestine—and hence is met with in subphrenic abscess and in some of the many types of abscess associated with appendicitis, but it is sometimes the result of infection with a gas-producing organism—*e g*, the *B aerogenes capsulatus* or *B œdematis maligni*. This latter type is rare apart from spreading gangrene, but a few years back one of us opened a perineal abscess in a diabetic patient, from out of which the gas literally whistled, whilst in a few days emphysema had spread over the whole trunk, in spite of incisions to limit its progress. Very extensive sloughing followed, and the patient died. The *B œdematis maligni* was isolated in this case. Some gas-containing abscesses (especially those near the alimentary canal) are due to *B coli*, either alone or in admixture with other organisms.

The **Diagnosis** of an acute superficial abscess usually presents no difficulties, the sense of fluctuation supervening in the midst of an area previously inflamed and brawny being quite characteristic, sometimes, however, all that can be detected is a feeling of elastic resistance in the centre of the hyperæmic indurated focus, but this, to the practised finger, is quite as conclusive of the presence of fluid as fluctuation. When the pus is placed deeply under muscular and fascial planes, very careful examination may be needed in order to determine its presence, the surgeon must not be misled by the sense of fluctuation obtained across the fibres of a muscle, none is noticed,

however, by palpating along the course of its fibres. In cases of doubt a blood count should be made, and the demonstrated presence of leucocytosis would be an important diagnostic feature (p 48)

**Treatment of Acute Abscess** — When an inflamed area is threatening to suppurate, the formation of pus can be but rarely *prevented*. In the early stages, elevation and rest of the part, together with the application of evaporating lotions and the administration of quinine with iron, may sometimes succeed in accomplishing this. The hypodermic injection of powerful antiseptics — *e g*, pure carbolic acid — has also been employed to destroy the pyogenic organisms *in situ*, whilst in some cases (*e g*, in acute periostitis) a free incision through the inflamed tissues is permissible.

In a few regions of the body, pus may be *absorbed* after its formation, but only when situated in a cavity of highly-absorbing powers, such as the anterior chamber of the eye (hypopyon), or perhaps some of the serous cavities, *e g*, the peritoneal. In the former the process of absorption may certainly be observed under the influence of local and general treatment.

As a rule, however, one encourages suppuration by applying fomentations or poultices to the part, and then as soon as pus is evident, an incision is made to *evacuate* the abscess cavity. The opening must be large enough to prevent reaccumulation, it should be placed at a spot suitable for drainage, but as far as possible from sources of septic contamination, and in such a direction that movements of the part do not close it. In dealing with deep abscesses in dangerous regions, *Hilton's method* may be advantageously employed. It consists in merely dividing the skin and superficial structures, and then thrusting a director into the abscess cavity, a pair of sinus or dressing forceps is now passed along the groove, and on forcibly separating the blades a sufficient opening is made to insert the finger and subsequently a drainage-tube. Rigid antiseptic precautions must be taken in opening abscesses, for although bacteria are present, it is most essential that no fresh germs be admitted, thereby giving rise to a mixed infection, the presence of which is most unfavourable to rapid repair.

**Methods of Opening Various Abscesses** — *Axillary Abscess* — Cut in the median line of the axilla towards the chest from above downwards, and use Hilton's method thus escaping the three main sources of danger, viz the axillary vessels above the long thoracic in front and the subscapular vessels behind.

*Inguinal Bubo* — Make a vertical incision from below upwards the patient standing erect against a wall or lying down. When he sits the incision gapes, and so accumulation is prevented.

*Intramammary Abscess* — Cut in a direction radiating from the nipple to prevent injury to the galactophorous ducts, and pass a finger in so as to open up all the dilated lobules.

*Submammary Abscess* — Open along the lower margin of the breast and if possible towards the outer side carefully avoiding the glandular tissue.

*Retropharyngeal Abscess* — Incise along the posterior border of the sterno-mastoid for about an inch draw that muscle and the carotid sheath forwards open by Hilton's method pushing a director inwards to the middle line immediately in front of the transverse processes guiding it by means of the left index finger placed on the swelling in the mouth.

*Ischio rectal Abscess*—Place the patient leaning over the back of a chair, or in the lithotomy position if an anæsthetic is employed, and incise vertically and very freely, as far from the anus as possible, healing may ensue without opening the rectum. In some cases where the skin is undermined, a crucial incision should be made the resulting corners of skin being removed.

In opening a *Palmar Abscess*, care must be taken not to wound the superficial palmar arch or its digital branches. It is best accomplished by entering the knife immediately in a line with the centre of the metacarpal bones, cutting forwards to the base of the finger.

It is advisable to gently squeeze an abscess after opening it, especially if sloughs are present, or when it has burrowed, if the cavity is large, it should be explored with the finger. All that is subsequently needed, if there is no complication, such as the presence of dead or diseased bone, is to arrange for drainage, as by inserting a drainage-tube or a slip of protective, and to exclude sepsis by a carefully applied antiseptic dressing, in other cases it may be desirable to pack the cavity with gauze soaked in an iodoform emulsion (10 per cent). There is often a considerable loss of blood during the first twenty-four hours from the yielding of the capillaries in the abscess wall, owing to the sudden relief of tension, but this usually ceases of itself, or yields to moderate pressure. *When once the abscess has been evacuated, no more pus is formed if external contamination (mixed infection) has been avoided*, the discharge being merely serous, and the wound rapidly closing and healing. Our colleague, Mr G. L. Cheate, has pointed out that, although no more pus is formed, the cavity and its lining wall still for a time contain bacteria, and perhaps in a state of virulence, but they are evidently unable to develop or do any harm, possibly from the tissues being immunized or protected against them. The persistent discharge of pus from an abscess which has been opened means either that matter is pent up in a loculus of the cavity which has not been drained, or that a mixed infection has occurred, or occasionally that the vital powers of the patient are so deteriorated that it is difficult to establish healthy repair. In the first of these conditions the wound must be carefully explored and a free opening established into the loculus, or a *counter opening* may be made by pushing the finger, or a probe, through the abscess wall amongst the tissues, making it protrude beneath the skin at some dependent spot, and cutting down upon the finger or probe in this direction. Pus which stinks on its escape usually loses all smell in a day or two, the wound pursuing a normal course, unless the abscess communicates directly with the bowel.

### Chronic Abscess of Pyogenic Origin

A chronic abscess may be defined as a collection of pus which forms slowly and without any signs of active inflammation, so that it is sometimes termed a *cold* or *congestive* abscess. The vast majority are tuberculous in origin, but a few may be due to the liquefaction of other granulomatous masses, to an infection with pyogenic bacteria of low vitality, or to chronic pyæmia. It may, however, be taken for granted that when a chronic abscess is spoken of, it is of a tuber-



culous nature, unless otherwise stated. The clinical phenomena are alike in the two types, and will be dealt with later (p 167); but there is one important distinction between them in that the lining membrane of the pyogenic variety is merely granulation tissue more or less active, whilst in the tuberculous form it contains active tuberculous material. Hence, whilst a simple incision under aseptic precautions is all that is required in the former, the latter also needs removal of the tuberculous tissue by scraping or some such agency.

### Sinus and Fistula

When an abscess has been opened, and does not completely heal, a communication often persists between the original seat of the disease and the exterior, which is known as a sinus or fistula. A Sinus is a narrow track lined with granulations, penetrating into the tissues, open at one end and closed at the other, the discharge is purulent or merely serous according to whether or not sepsis is present. A Fistula is an abnormal communication, congenital or acquired, between two cavities, or between a cavity and the external surface. When such conditions result from the non-closure of an acute or chronic abscess of pyogenic origin, the walls consist of an external fibro-cicatricial vascular layer, merging on the outside into healthy tissues, and an internal lining of more or less healthy granulation tissue. Should the abscess have been of tuberculous origin, the lining membrane will also contain tubercles. If the fistulous track is short, there is a tendency for the granulating wall to become covered with epithelium, and under such circumstances it cannot be expected to close until the epithelium has been removed, and a raw surface again exposed.

It is often a matter of difficulty to secure the healing of a sinus or fistula, and the following are the main *causes of their non-closure* (1) The presence of some chronic irritant in the depths of the wound, such as a piece of the clothing, a catgut ligature, a piece of silk or silver-wire used in an operation, or of some diseased tissue, such as a fragment of dead or carious bone, (2) the irritation of discharges finding an exit through the abnormal opening, such as urine, fæces, or foetid pus, (3) insufficient drainage of a deep cavity, so that there is always a certain amount of tension in the wound, (4) want of rest to the part, due either to voluntary movements, as in the limbs, or to involuntary muscular action in the immediate neighbourhood, as in fistula-in ano, (5) tuberculous infection of the wall, or a tuberculous deposit at the bottom of the sinus, (6) the growth of epithelium down the sinus or round the margin of the fistula, or (7) constitutional debility.

The orifice of a sinus often looks depressed from the amount of infiltration around, but when the surrounding tissues are healthy, puckering in of the orifice is a good sign, in cases where foreign bodies are lodged within, or where diseased bone exists, it is usually surrounded by prominent fungating granulations.

**Treatment** —The removal of the cause is the first thing to accomplish in dealing with a sinus or fistula. The passage must be dilated or slit up to allow of access to the deeper parts of the wound, to remove any foreign body which may be present, or to allow of the satisfactory drainage of a deep cavity. The making of a dependent counter opening often suffices to cure a sinus. A thorough purification of the part by pure carbolic acid or chloride of zinc must also be undertaken, and the wound dressed by plugging with suitable material and kept at rest, whilst the general health of the patient is improved by tonics. Occasionally, the pressure of a roller bandage to immobilize the part is all that is required, or the application of a suitable splint. The most complete and certain method is to lay the sinus open and thoroughly destroy the lining granulation tissue by scraping or cauterizing, and then to plug the wound, allowing it to heal from the bottom by granulations.

Should a fistula have become lined with epithelium, the edges will require paring, and some form of plastic operation must be undertaken to close the opening.

### Results of Long-continued Suppuration

When an abscess, acute or chronic, pyogenic or tuberculous, is emptied antiseptically, and maintained in an aseptic condition, the formation of pus usually ceases, the wound may remain open for months, but the discharge is merely serous, and no constitutional results will be manifested. The temperature is normal, and the general health unimpaired, if no other disease is present. Should such an abscess become septic, or a mixed infection occur, the discharge of pus continues or reappears, and if the abscess is of deep origin, may become profuse and even offensive, fever supervenes, and grave visceral changes occur, which sooner or later may lead to the patient's death from exhaustion. *Long-continued suppuration is always an evidence of sepsis*, and from it two conditions may arise, viz, hectic fever and lardaceous disease.

**Hectic Fever** may be defined as a chronic toxæmia or condition of blood-poisoning, due to the continual absorption of small doses of toxins, and is met with in any condition of chronic sepsis, *e g*, after acute or chronic suppurative affections of bones or joints, in tuberculous disease of the lungs, and in septic syphilitic or cancerous disease. It is characterized by a regular diurnal elevation of temperature. During the evening the face becomes flushed (*hectic flush* of the cheeks), the eyes are bright and sparkling, the pupils dilated, and the patient feels better and stronger. The pulse, however, is small, compressible, and ten or twenty beats quicker than it should be, the tongue becomes red at the edges and tip. This condition continues till late in the night, by which time the temperature may have risen four or five degrees. It then commences to fall as rapidly as it had formerly risen, and usually drops to the normal, or even below it, and in the early morning a profuse

perspiration breaks out which soaks the patient's clothes, and leaves him in a much exhausted condition. Day by day this continues, the fever and sweating together causing a marked diminution in the patient's strength.

**Amyloid, Albumenoid, or Lardaceous Disease** of various organs is also present in cases of long-standing suppuration. As to the cause of this curious condition but little is known, either from the deleterious effects of toxic compounds circulating in the blood, or from the loss of some special substance in the discharge, *e.g.*, alkaline phosphates, the walls of the smaller arteries and the protoplasm of

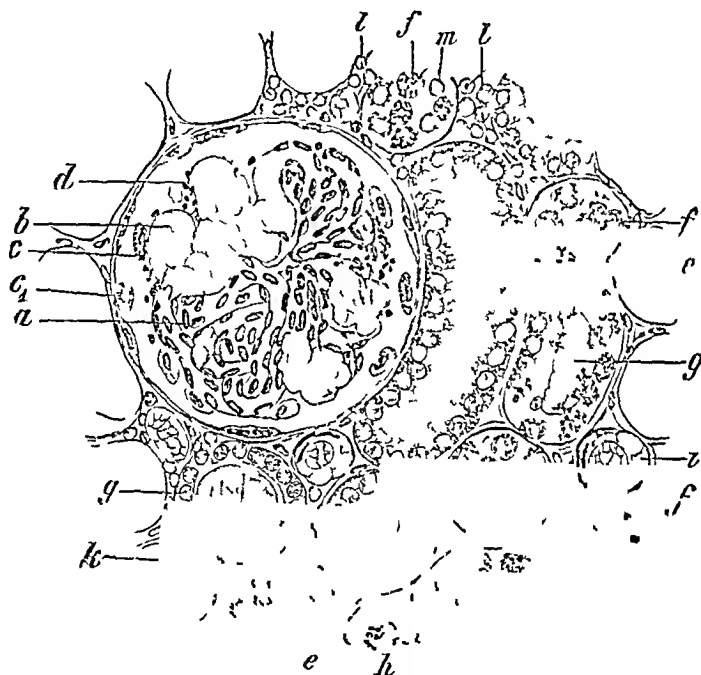


FIG 9—AMYLOID KIDNEY IN EARLY STAGE (ZIEGLER)

(Treated with Muller's fluid and perosmic acid  $\times 300$ ) *a*, Normal capillary loop *b* amyloid capillary loop, *c*, fatty epithelium of glomerulus *c*<sub>1</sub>, fatty epithelium of capsule, *d*, oil drops on the capillary wall *e*, fatty epithelial cells *m* *situ* *f*, loosened fatty epithelial cells, *g*, hyaline coagula (forming casts) *h* fatty cast in section *i*, amyloid artery, *k*, amyloid capillary *l*, infiltration of connective tissue with leucocytes, *m*, round cells (leucocytes) within a uriniferous tubule

certain of the viscera are converted into or infiltrated with a waxy substance, from which lardacein, an extremely insoluble proteid body, may be obtained. The name 'amyloid' is an entire misnomer, as this material is in no way akin to starch. It occurs as a waxy homogeneous material, becoming a dirty brown on the application of tincture of iodine, and an inky blue when sulphuric acid is subsequently added. With methyl-violet the amyloid substance is coloured ruby-red, whilst normal tissues are stained blue or indigo.

The organs mainly affected are the liver, spleen, kidneys, and villi of the intestines, and the capillaries and muscular coats of the arterioles (Fig 9, *b* and *c*) are the parts first attacked, the change gradually spreading to the parenchyma of the organ. The *liver* becomes evenly enlarged to a considerable degree, often reaching from the fifth rib to the umbilicus, or lower, it is firm in consistency, like indiarubber, painless, and waxy-looking on section. The arterioles and capillaries in the intermediate zone of the lobules are those first affected, but the cells soon participate in the change. The glycogenic and bile producing functions are naturally interfered with, so that the digestive process, and especially the power of absorbing fats, is impeded. The *kidneys* become similarly enlarged, the change commencing in the arterioles leading to the glomeruli (Fig 9), but the capillaries and the tubal epithelium are also early affected. In this stage the urine is very abundant (from the increased filtration through the degenerated walls), pale, limpid, and containing a few hyaline casts and fatty cells, later on, when the tubules are more largely involved, there is less urine, with a higher specific gravity, and a considerable amount of albumen. The *spleen* increases in size, but not always to so great an extent as the other viscera, the Malpighian bodies are the chief seat of the mischief. The capillaries in the *villi of the intestines* become lardaceous, and allow of an increased transudation of the fluid parts of the blood, resulting in diarrhoea, the absorption of nutriment is thereby much lessened, and thus both by increased excretion and diminished absorption of food the strength of the patient is steadily undermined.

Amyloid changes in the viscera, far from being a contra-indication to operation, are rather to be considered as a sign that radical treatment is urgently necessary, unless the general condition of a patient is such that he cannot stand the strain of it. If by an operation, *e g*, excision or amputation, the local disease can be eradicated, the amyloid changes in the viscera may totally disappear. At the same time one must not forget that the kidneys are seriously damaged, and that antiseptics, such as carbolic acid, which are absorbed into the blood and eliminated in the urine, may light up an acute nephritis with possibly fatal results.

## II Cellulitis

Cellulitis (or, as it used to be termed, *diffuse phlegmon*) is a disease characterized by the existence of a spreading inflammation of the subcutaneous or cellular tissues, due to the activity of pyogenic organisms, and running on to suppuration, sloughing, or even to extensive gangrene.

**Causation** — The one essential is the infection of the cellular tissues with organisms which gain an entrance through an operation wound which has been allowed to become septic, or through an accidental breach of surface which has not been rendered aseptic, or even through the slightest graze, prick, or scratch. Deep septic wounds

which are not properly drained are amongst the most favourable for the development of this condition, especially if the general health of the individual is bad, if he is suffering from albuminuria or diabetes, or if his surroundings are of an insanitary nature. Wherever much loose cellular tissue is present, inflammatory phenomena readily supervene, owing to the absorption of septic material from neighbouring contaminated structures, *e.g.*, pelvic cellulitis arising from a septic uterus.

**Bacteriology**—The *Streptococcus pyogenes* is the organism most frequently found in cases of cellulitis, particularly when there is much tendency to spread. In some of the more localized forms the *Staphylococcus pyogenes* is present, whilst in the gravest and most acute manifestation the *B. adermatis maligni* is responsible for the trouble (p. 108), and the disease is then identical with what is usually known as acute emphysematous or infective gangrene.

**Clinical History**—The symptoms necessarily differ somewhat according to the site of inoculation and the virulence of the causative microbes, and hence anything from a localized suppuration to the acutest form of spreading gangrene may result. In a case of moderate severity, due to a prick or abrasion which has become infected, there is often a period of quiescence for a day or two, during which the virus is incubating, and the site of inoculation shows but slight signs of inflammation, beyond being a little tender. The patient, though feeling somewhat seedy, is able to continue his work, but is finally obliged to give up, owing partly to the increased pain, partly to his general condition. Fever will almost always be present to a greater or less degree, and in the more severe types one or more rigors occur, or the temperature may be subnormal, owing to the intensity of the toxæmia. The affected part is found to be hot, tender, and infiltrated, if superficial, it looks red and angry, and feels brawny. The course of the case depends to a very large extent upon the treatment adopted, if freely incised, the process becomes limited, and although suppuration may occur, there is but little sloughing, and hence repair is readily effected, if, however, it is left or is merely poulticed, the process rapidly spreads, and extensive destruction of tissue may follow. Intense pain and sleeplessness, accompanied perhaps with delirium, form the most prominent symptoms, and these, together with the toxic fever, rapidly exhaust the patient's strength. Suppuration at length occurs, but it is often of slow development, and the swelling may remain hard and brawny for some time in such a region as the neck with no evidence of softening, it is, therefore, sometimes very difficult to determine whether pus is present or not. The infiltrated cellular tissues are likely to slough, and in a limb extensive subcutaneous necrosis may occur, although the skin only gives way in places. Hence it is often possible to pass a probe between the skin and the deep fascia over a considerable area. Sometimes the inflammation skips a part of the limb, the chief focus of mischief being found at a distance from the original site of inoculation, whilst the intervening portion

is but little affected. Occasionally the trouble spreads along the deeper areolar planes, involving muscular bellies, which may be infiltrated with pus or may actually slough. This is most likely to occur when the disease is due to septic inflammation following a penetrating wound, such as a gunshot injury or a bad compound fracture. In all these more severe forms the patient runs a considerable risk of developing general septicæmia, or even pyæmia.

**Treatment**—With the exception of cases of emphysematous gangrene, cellulitis results from the activity of organisms which are readily destroyed, and over which the germicidal properties of the body have considerable control. Hence careful attention to the dicta of antiseptic surgery can prevent its occurrence to a very large extent. Abrasions and small punctured wounds should always be carefully protected, and all penetrating injuries disinfected, especially if the patient runs exceptional risk of infection owing to his occupation or surroundings. Should inflammatory phenomena supervene, the application of antiseptic fomentations, such as the boracic poultice, may prevent their extension, whilst the bowels should be freely acted upon and the general health attended to. Failing this, and if there is any tendency for the inflammation to spread, incisions should be made into the brawny tissues, so as to give exit to the serous and irritating discharges, and to allow sloughs to be cut or scraped away, the wounds thus made are dusted with iodoform and lightly packed with gauze, over which the usual dressings are applied. The object of this is to drain the fluids from the parts by capillary action, and hence an effective junction must be maintained between the gauze drain and the surrounding dressing. It is often wise to incorporate a piece of mackintosh in the outer folds of the dressing, so as to keep the parts moist and encourage a free discharge. Under such a régime sloughing may be entirely prevented, or, at any rate, limited. At the same time the patient's health and strength must be maintained by the administration of suitable food, drugs, such as quinine, and stimulants.

Another excellent plan of treatment is to immerse the wounds, after freely incising the infiltrated parts, in a continuous warm bath, by this means diluting the toxins to such an extent as to render them innocuous. Warm sterilized water does perfectly well, antiseptics are practically useless in checking the disease when once started, the surgeon has to depend mainly on relief of tension, the removal of toxic discharges, and the antiseptic power of the tissues. At the same time the utmost care must be taken to prevent any fresh or mixed infection of wounds from decomposition of discharges.

Antistreptococcic serum has also been employed as a curative agent, with a view to destroy the streptococci (probably by a bacteriolytic action) and immunize the system to their further development. It consists of the blood serum of an immunized horse, to which some antiseptic has been added in order to preserve it. The dose varies from 5 to 10 c.c. (1 c.c. =  $\frac{1}{17}$ ), injected two or three times a day beneath the skin of the back or abdominal wall.

The results have been very variable, sometimes it is most effective, but not unfrequently the results have been most disappointing. This is probably due to the extraordinary differences in virulence between different strains of streptococci.

### Special Varieties of Cellulitis

**Cellulitis of the Axilla** not unfrequently follows an infected wound of the hand, such as occurs in the post mortem room, and hence is not uncommon in medical practitioners students or nurses. It may also be caused by extension from a primary axillary lymphadenitis. The tissues of the armpit become hard and brawny, the pain is severe and the disease is liable to spread towards the chest walls under or between the pectoral muscles. It may also travel upwards and lay open the shoulder joint from sloughing of the capsule, and so give rise to an acute arthritis. Extensive incisions are required in order to prevent such complications, but respect must be paid to the important vessels and nerves contained in the cavity.

**Submammary Cellulitis** is usually due to an extension of inflammation from the deeper parts of the breast or perhaps from the cartilages or bones of the chest wall. The areolar tissue beneath the breast becomes infiltrated and brawny and the gland itself is lifted up and somewhat swollen and tender. (See Submammary Abscess.) Free incisions must be made into the infected area along the lower portion of the circumference of the organ.

**Cellulitis of the Scalp** results from a septic wound which has traversed the occipito frontalis aponeurosis and opened up the subjacent layer of loose areolar tissue. Suppuration extends to the limits of attachment of this structure, and hence abscesses are likely to point in the forehead just above the eyebrows, over the zygoma, or along the superior curved line of the occipital bone, in addition to the severe general disturbance, the patient runs a risk of necrosis of the skull and of various intracranial complications.

**Cellulitis of the Orbit** is not an uncommon sequela of penetrating wounds in this region, owing to the difficulty of rendering them aseptic and of draining them. The whole of the orbital tissues become infiltrated and swollen, the lids are cedematous and the eyeball is thrust forwards. There is a considerable likelihood of the inflammation spreading to the meninges, owing to the dura mater being continuous with the orbital periosteum through the foramina by which the nerves and vessels enter. Necrosis of the orbital walls may also occur, whilst the eye itself may suffer either from an infective panophthalmitis due to lymphatic infection, or from optic neuritis secondary to retro-ocular inflammation and pressure, or at a later date from optic nerve atrophy secondary to cicatricial contraction around the nerve. If the cellular tissue of the orbit sloughs the subsequent movements of the globe may be much hampered, or indeed lost, whilst the lids may be drawn back to such an extent as to prevent their complete closure. *Treatment*—No penetrating wound of the orbit ought to be closed if there is any question of its infection; indeed, it is often wise to slightly increase its size so as to enable the deeper parts to be cleansed. Drainage must always be provided for, and in many cases this is best accomplished by stuffing it lightly with gauze. If cellulitis follows, the original wound must be opened up, and possibly fresh incisions made either through the lids or through the fornix conjunctivæ. Antiseptic fomentations or poultices are then applied. If panophthalmitis supervenes, the eyeball must be incised crucially; this is a safer proceeding than enucleation, which is more liable to be followed by meningitis.

**Cellulitis of the Neck** is a painful and serious affection which is usually secondary to a septic throat, and may therefore be associated with follicular tonsillitis, diphtheria or scarlatina. In it the tissues beneath the deep cervical fascia become infected usually with streptococci and sooner or later suppuration occurs. The affected side of the neck becomes swollen, red and brawny; severe pain of a deep tensile character is experienced, and this is increased by move-

ments of the head or jaw. The swelling is often peculiarly hard and resistant, and although œdema may be present, it may be several days before the surgeon can detect any foci of softening suggestive of suppuration. During this period the constitutional symptoms are severe, fever may be high, and the pain and subsequent sleeplessness may exhaust the patient, whilst the difficulty of swallowing hinders his nutrition. Dangerous symptoms arise from pressure on important vessels and nerves, from extension of the inflammation to the glottis, causing œdema and consequent dyspnœa, or from the supervention of pyæmia owing to venous thrombosis. The process usually ends in sloughing of the cellular tissue and suppuration, the pus burrowing widely if a free exit by incisions through the deep fascia is not provided.

*Treatment* —The causative lesion in the throat must be attended to, and the general condition improved by the administration of nourishing fluid food stimulants, and quinine. Antistreptococcic serum may also be injected. Locally fomentations are applied in the first place, but on the onset of suppuration, or before, if the pressure symptoms are severe, or if the affection is obviously extending, free incisions must be made along lines of safety beneath the deep fascia so as to relieve tension and give exit to discharges. It must be remembered that the tissues are matted together in such a way as renders their recognition difficult, and inasmuch as the pus often lies deeply, the greatest caution has to be taken to avoid injury of important structures.

Special interest has been directed to a form of this affection which occurs in the *submaxillary* region and is known as *Ludwig's angina*. It is usually secondary to some buccal focus, or may occasionally result from the extension of inflammation beyond the capsule of lymphatic glands, or may originate in disease of the middle ear, the mischief spreading down along the posterior belly of the digastric. The swelling in these cases extends forwards beneath the chin, and may involve the base of the tongue, pushing that organ forwards, and even making it protrude from the mouth. Œdema of the glottis may supervene, or a sublingual abscess form. Treatment is similar to that indicated above, and if an incision is needed, it will probably have to be placed in the median line.

**Pelvic Cellulitis** arises from extension of inflammation from the pelvic viscera to the loose cellular tissue ensheathing them. It may be due to lymphatic absorption from septic material contained in the uterus, or it may spread from the ovary, Fallopian tube, or prostate. Injuries to the bladder or rectum may also light up the trouble. It is associated with all the local and general signs of deep inflammation, and often indeed, with peritonitis giving rise to a tense firm, painful swelling, to be felt *per vaginam* or *per rectum*, and sometimes to an indurated mass of inflammatory effusion dull on percussion, above the pubic arch. Abscesses may form in this effusion, bursting either externally or into some of the viscera, or possibly in both directions, producing very intractable forms of urinary or fecal fistulæ, whilst venous obstruction and pyæmia are very likely to develop.

The surgeon may be called on to deal with such cases either in the early pre-suppurative stage, when rest, limitation of diet, small doses of opium, and fomentations to the hypogastrium conjoined perhaps with hot antiseptic vaginal or rectal douches, should be adopted, or at a later date, when pus has formed and the abscesses need to be opened. An incision is generally made just above Poupart's ligament and close to the pubic spine, the abdominal muscles are divided to a sufficient extent to enable the surgeon to work downwards between the transversalis fascia and the peritoneum, which must be pushed aside in order to reach the broad ligament, where pus is frequently found. As soon as the sub-peritoneal tissue is opened the knife should be discarded, and only blunt instruments or the fingers employed. The cavity of the abscess should be well washed out and efficiently drained, and possibly a counter-opening through the vagina may be required.

Intestinal obstruction may develop as a remote sequela from the contraction of cicatrices, and hydronephrosis may arise in the same way from pressure on the ureter.



### III Sepsis and Sapræmia

**Sepsis** is a term somewhat loosely applied to indicate that a wound or sore has become infected with micro-organisms in such a way as to interfere with healthy reparative action. It is seen in connection with casualty wounds, and less frequently in operation cases, it occurs in abscess cavities, and in connection with other unprotected sores and abrasions, and the offensive odour which so often accompanies neglected syphilitic or cancerous lesions is simply due to this, and is no essential part of the causative affection.

The organisms present are usually of the ordinary pyogenic type, especially the staphylococci and streptococci, but other saprophytic germs may sometimes be found, constituting a mixed infection.

When it arises in connection with a casualty or operation wound, it is usually due to contamination from a dirty state of the skin, impure instruments, ligatures or sutures, unsterilized hands of the surgeon or assistants, or some other fault connected with the operative technique, very rarely it is due to auto infection or to the fact that pyogenic germs are lying latent in the part as the result of some former infective trouble in the neighbourhood. The local trouble is acute or subacute, according to the virulence of the organisms and the resisting powers of the patient, it may manifest itself merely as a suppurative process within the wound, or as an active cellulitis spreading into the adjacent tissues. It may commence deeply around a buried stitch or superficially. In the latter case the lips of the wound look red and puffy, the tissues often swell up between the stitches, which look as if they were too tight, the patient complains of pain, usually of a throbbing nature, and there is some rise of temperature, and in bad cases even a rigor. In the milder forms, the trouble is limited to the immediate neighbourhood of the wound, but if neglected, or in an unhealthy subject, or if due to virulent germs, the phenomena of an acute cellulitis may supervene, whilst the general condition may constitute an attack of septic traumatic fever, or may even run over into a true septicæmia.

When the process starts quietly in the deeper parts of the wound, nothing may be obvious on the surface for a few days, except perhaps some fulness and tenderness on pressure. It will usually be found, however, that the temperature is slightly raised, and that some tensive pain is present. Sooner or later an abscess develops and comes to the surface.

The local treatment of a septic wound consists essentially in the relief of all tension, the removal, as far as possible, of all putrescible material, and the application of warmth and moisture to the part, if superficial, to encourage the local reparative activity of the tissues. Stitches must be immediately removed, and the wound widely opened up, care being taken to ascertain whether or not the pus has burrowed, as if so it must be followed up, sloughs may be cut or scraped away under an anæsthetic, or left to separate by natural processes. The parts are then thoroughly washed out with warm

salt solution or dilute antiseptics, and may advisably be treated with peroxide of hydrogen, it must not be forgotten that where the organisms have invaded the living tissues, no antiseptic is likely to reach them—at any rate, not without also destroying the tissues, and therefore, powerful or irritating antiseptics should be avoided. The wound is then lightly, though thoroughly, packed with gauze, soaked in an emulsion of iodoform and glycerine, and if there is a deep cavity, it may be desirable to introduce a drainage-tube, especially when suppuration is present, since pus does not easily escape along a gauze drainage wick. It is not advisable to pack the gauze into the wound too tightly, as thereby the escape of secretions may be prevented, and pain and tension may ensue, whilst possibly bacteria may be driven into the tissues and give rise to further trouble in the nature of erysipelas or cellulitis. Warm, moist dressings, such as an antiseptic fomentation, are then applied, or it may be desirable either to immerse the limb in a hot antiseptic bath for an hour or two daily, or to keep it in for some days. At the same time the bowels must be freely opened, and the general health of the patient carefully watched. The more serious cases are dealt with in the same manner as an attack of cellulitis (p. 73).

The *general* phenomena connected with septic conditions vary chiefly in respect of the dose of toxins absorbed from the local focus.

1 When the dose is small, but if it is absorbed regularly and for a long time, a definite diurnal range of temperature follows, known as *hectic fever* (p. 69). It is always associated with persistent and prolonged suppuration.

2 **Septic Traumatic Fever** is due to the absorption of a somewhat larger amount of the poison after an operation or injury, which is followed by septic inflammation. A burn or compound fracture which is not rendered aseptic is always accompanied by fever, ranging from  $102^{\circ}$  to  $104^{\circ}$  F for some days, until the wound is securely sealed off by the development of granulation tissue. When once this has occurred, the fever usually disappears, unless septic material is retained under pressure. The actual phenomena connected with such an attack are in no way peculiar.

3 **Acute Sapræmia, or Septic Intoxication**, results from the absorption of a large dose of toxic material. This condition was for long confounded with true infective septicæmia, and even now, though clearly distinguished pathologically, a clinical distinction between the two is not always possible. Sapræmia is essentially a toxæmia, or condition due to chemical poisoning, the blood is not infective, and the symptoms are directly proportionate to the dose. Any condition in which there is a large mass of putrefying tissue or fluid from which absorption can occur may lead to sapræmia—e.g., a portion of decomposing placenta in the puerperal uterus, the existence of septic pus under pressure in the peritoneal cavity, a joint, or elsewhere, or a mass of putrefying blood-clot, say, in the pleural cavity after a penetrating wound.

The **Symptoms** usually commence, two or three days after the

cause has come into operation, with a severe rigor, followed by a maintained high temperature, although sometimes it is subnormal in the more serious cases. This is associated with loss of appetite, a dry tongue, a quick pulse, rapidly becoming weak, severe headache, and nocturnal delirium of some intensity. The patient is at first constipated, but vomiting and diarrhoea may ensue from gastrointestinal irritation, followed by fatal exhaustion and collapse, or he may become comatose and unconscious for some time before death, according to whether the toxins act chiefly upon the alimentary system or upon the cerebral centres. Dyspnoea, from pulmonary congestion, and albuminuria also occur. Should, however, the putrefying mass be removed in time, the fever will cease as by magic, the tongue cleans, the appetite returns, the headache vanishes, and in twenty-four hours the patient feels a different individual.

**Post-mortem Appearances** — Decomposition is early, rigor mortis feeble, and cadaveric lividity well marked, especially along the lines of the superficial veins and posteriorly. The blood coagulates imperfectly, and is dark and tarry in colour, if allowed to stand, the serum which separates from the corpuscles is much stained from the breaking up of the red-blood cells which occurs in all septic and infective cases. This condition explains the amount of cadaveric lividity, and also the post mortem staining of the endocardium and tunica intima of the larger vessels, which is such a marked feature in these cases, and which was formerly supposed to result from a diffuse arteritis. Most of the serous cavities contain a certain amount of blood-stained fluid, and under almost all the serous membranes are well-marked petechiæ, especially under the pericardium and pleura. The lungs are deeply congested, particularly at the back, and very œdematous, the liver, spleen, and kidneys are enlarged, pulpy, soft, and congested, notably the spleen. The epithelium of most of the secreting glands, if examined microscopically, gives evidence of cloudy swelling.

The **Treatment** of acute sapræmia must be chiefly directed to the local cause, which is dealt with by suitable surgical means. General treatment is merely symptomatic. Possibly a good purge may be advisable in the early stages, but in the later a supporting and stimulating plan of treatment must be adopted. Recently it has been proposed to deal with the acute toxæmia of peritonitis and similar conditions by the repeated injection into the veins of large quantities of saline solution (3i ad Oj), and excellent results have been obtained by this means, the injections being followed by diuresis and diarrhoea, which presumably assist in the elimination of the poison.

#### IV Septicæmia

**Septicæmia** is an acute general infective disorder, arising from the development of some variety of pyogenic organism in the blood. It differs from pyæmia in the absence of secondary abscesses (although, as explained later, it may be associated with it), and from sapræmia

or septic intoxication by the fact that the latter is merely a chemical toxæmia, due to the absorption into the blood of toxins generated in a diseased focus in which the bacteria themselves remain localized. In septicæmia the bacteria occur in the blood of the general circulation, though in many cases in but scanty numbers, so that it is necessary to take rather large quantities of blood (5 c c or more) for a bacteriological examination. Further, even in severe cases of septicæmia periods occur in which no bacteria can be detected in the blood, so that too much weight should not be attached to a single negative result. In sapræmia, on the other hand, the bacteriological examination of the blood shows it to be invariably sterile.

**Bacteriology**—A large number of micro-organisms have been isolated from the blood in cases of septicæmia. The commonest organism is undoubtedly the *Streptococcus pyogenes*, which is found in about 50 per cent of all cases, it is almost always found in the septicæmia dependent on puerperal diseases, though in these cases it may be associated with other organisms. It is also the most frequent cause of ulcerative endocarditis, a disease practically identical with septicæmia, except in so far as the lesion in the heart acts as the source of the bacteria in the circulating blood. Next in frequency is the *Pneumococcus*, which often causes septicæmia, even when no pulmonary or other local lesion can be traced. The *Staphylococcus pyogenes* is also a fairly common organism in this disease, and the prognosis is then decidedly better than in cases due to the streptococcus or pneumococcus.

Rare causes are the *B. coli* and allied organisms, *B. pyocyaneus*, *B. adenatis maligni*, the *pneumo-bacillus*, and the *gonococcus*.

**Clinical History**—Septicæmia occurs most commonly from direct inoculation with suitable organisms through small lesions, such as post-mortem wounds, or from scratches or punctures with infected pins or instruments, it also in rarer cases follows operation wounds and severe lacerated injuries. It is the usual accompaniment of acute spreading gangrene (p 108), and may be met with in cellulitis and cancrum oris (p 109). As a rule, the individual attacked is in a depressed and debilitated condition, often deteriorated by alcoholic or other excesses, so that the inherent germicidal activity of the tissues is markedly insufficient to cope with the inroads of the disease.

The point of inoculation may be the seat of any of the forms of local trouble which we have already described under the title of cellulitis, and this may vary from a slight inflammatory blush to the acutest form of spreading gangrene.

The **General Symptoms** are those of fever, often ushered in by a distinct and severe rigor, the temperature reaches 104° or 105° F and usually remains high, with but slight remissions and no intermissions. Malaise is present, with loss of appetite, the tongue is brown and parched, the pulse quick and feeble whilst the skin has often a slight icteric tinge. Diarrhœa usually ensues, and may be blood-stained, whilst the urine is albuminous and contains blood. Petechiæ appear under the skin, and the patient, after a period of

delirium, becomes comatose, and dies. Dyspnoea sometimes precedes the fatal issue, whilst the temperature may be exceedingly high, or occasionally subnormal, the association of a low temperature with a very rapid pulse is always of grave import.

*Illustrative Cases*—A servant girl aged about twenty two, complained one hot summer's day that she had been stung near the inner canthus by a fly, possibly the insect had come from some infected material, and thus poisoned the wound. In twenty four hours she was feeling ill and feverish, and had some chills and flushes, a painful swelling developed at the inner canthus, which rapidly increased in size and spread downwards. At the end of four days when we saw her, the eye was protruding and much congested, and a definite band of inflammatory thickening could be felt reaching from the roof of the nose across the face to the neck and jugular region, probably the thrombosed facial vein, the clot doubtless extending to the cavernous sinus. The temperature was high, and the girl was delirious. An incision was made into the orbit with the view of relieving tension and giving exit to any pus that might be present, but with no result. She rapidly became unconscious and died within a week.

An elderly man, addicted to drink, fell in the street, and grazed the inner side of his hand. Within twenty four hours the whole arm was puffy and swollen, and in two days gangrene had manifested itself the infiltration reaching beyond the shoulder. The patient was dead from acute septicæmia in five days.

The **Post-mortem Signs** are those found in all cases of acute septic poisoning, described above (p 78), with the addition that on microscopical examination bacteria can be demonstrated in the blood and internal organs.

The **Diagnosis** has to be made from the more virulent forms of the *acute exanthemata*, in which the patient is destroyed before the characteristic appearances are manifested, in such cases a definite opinion as to the nature of the affection is often impossible, if there is no clue as to the origin of the infection. *Sapriæmia* is always associated with some very obvious focus of putrefaction, whilst septicæmia may occur with but slight local manifestations. *Septic traumatic fever*, due to wound infection, may be so severe as to cause grave anxiety for a time as to whether or not septicæmia is present, but if the wound is freely opened up and drained, the rapid disappearance of the fever proves that the mischief was merely a local, and not the more serious general, affection. In both these conditions a blood examination may assist in clearing up the diagnosis. From *pyæmia* it is known by the absence of repeated rigors and secondary abscesses.

The **Prognosis** of septicæmia is always very grave, but it is to be hoped that the modern plans of treatment mentioned below, especially serotherapy, may prove beneficial in diminishing the mortality.

The **Treatment** consists in dealing actively with any local focus of inflammation, either by amputation, or by free incisions, purification, and drainage, but unfortunately this is seldom likely to be successful, as blood infection has probably already occurred. In addition to such means, tonics and stimulants, with plenty of suitable nourishment, must be administered.

It is possible that even this grave disease may become amenable to some of the therapeutic measures which have been suggested of recent years. Thus, the antistreptococcic serum (p 73) may be

utilized when the streptococcus is responsible for the trouble, and cases have been reported as cured by its agency. Another plan which has been adopted is that of the intravenous injection of considerable quantities of normal saline solution, repeated two or three times a day, by this means diuresis and diarrhoea are induced, and it is hoped that thereby the organisms and their products may be eliminated. This treatment has, however, been introduced so lately that no dogmatic statements can be made about it, it will probably be of greater value in cases of sapræmia than in those of true infective septicæmia.

## V Pyæmia

Pyæmia (Greek πύον, pus, and αἷμα, blood) is a disease characterized by fever of an intermittent type, associated with the formation of multiple abscesses in different parts of the body, arising from the diffusion of pyogenic materials from some spot of local infection.

**Bacteriology** — Any pyogenic organism may cause pyæmia, and, *theoretically*, pyæmia may arise as a complication following any acute abscess. As a rule, however, there is a sufficiently rapid development of granulation tissue to limit the spread of infection. The organism most commonly found is the *Streptococcus pyogenes*, but in a few cases the *Staphylococcus pyogenes aureus* has been observed, and less commonly the pneumococcus, or *B. typhosus*. The mere injection of cocci into the circulation is not sufficient to give rise to pyæmia, if they are few in number, a transient pyrexia may supervene, and then the germicidal powers latent in the blood destroy them, but if the dose is large, or the individual is not in a very resistant condition, septicæmia, and not pyæmia, results, unless special conditions are present which determine the formation of embolic abscesses. If the cocci to be injected are mixed with such a material or aggregated into such masses that the organisms are carried on particles too large to pass through the terminal arterioles and capillaries, abscesses develop wherever they lodge. In human pathology the infective emboli consist of zooglæa masses of organisms, or of infected particles of disintegrating blood-clot (Fig 10).

The Cause of pyæmia may be stated to be any condition which leads to the formation and detachment of infective emboli in the circulation, such conditions occurring mainly in the veins from infiltration and disintegration of a thrombus (*infective phlebitis*), but occasionally in the heart (*infective endocarditis*). The venous contamination which was formerly so much dreaded after operations has now been practically banished from surgery, but the disease is still

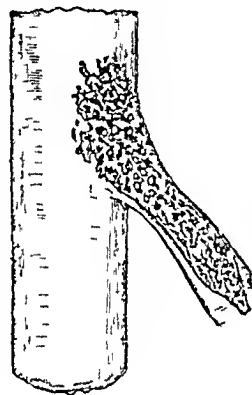


FIG 10 — DISINTEGRATING CLOT LYING IN A VEIN IN A CASE OF PYÆMIA (TILLMANN'S)

The apex of the clot projects into a larger trunk in which circulating blood is present and from it infected emboli would be detached.

occasionally met with in casualty work, where efficient asepsis is difficult. Acute infective inflammation of the cancellous tissue of bones is very commonly associated with pyæmia, owing to the veins being abundant and thin-walled, and considerable tension present from the unyielding condition of the surrounding bony structures. Inflammation of the cranial bones coming on in the course of middle ear mischief, and causing thrombosis of the lateral sinus, also leads to its development. The presence of large open-mouthed veins in the puerperal uterus favours the onset of the disease after parturition if septic material is present in their vicinity.

When an infective embolus lodges in any region of the body, a thrombus forms upon it, and in this the micro-organisms rapidly develop, and thence pass through the vessel wall into the surrounding tissues, causing inflammation, which is at first of a plastic type, but later on is likely to suppurate. In the lung many such foci may occur, distributed mainly along the posterior border and near the surface, each is sharply limited to a wedge-shaped area of tissue, with the base directed towards the periphery. It is at first reddish in colour from effusion of blood (a *hamorrhagic infarct*), but soon becomes grayish-yellow from the formation of pus. These abscesses are small, and rarely give rise to any physical signs. Similar collections of pus, preceded or not by an infarct, may be found in any organ of the body. The lungs, acting as a filter to emboli derived from the systemic veins, are naturally the first organs to be affected, and from the abscesses formed therein infection of the arterial system may take place, resulting in fresh suppurative foci in the liver, spleen, kidneys, brain, and in or around joints, etc. If, however, the causative phlebitis is situated in the portal area, the emboli are lodged primarily in the liver, giving rise to what is known as *pylephlebitis*. When the emboli are many in number, the symptoms are severe, constituting acute pyæmia, this is sometimes associated with a development of micro-organisms in the blood, producing *pyosepticæmia*, the patient perhaps dying before the secondary abscesses have fully developed. In other cases the general symptoms are due rather to the absorption of toxins from the local foci than to the development of organisms in the blood. If the emboli are few in number, and there is little or no development of microbes in the blood, the disease is termed **chronic pyæmia**.

**Clinical History** — The most marked symptom indicating the onset of a case of **Acute Pyæmia** is the occurrence during a period of febrile disturbance of a severe rigor, which is repeated with a sort of irregular periodicity, most frequently at intervals of about twenty-four to forty-eight hours, somewhat simulating an attack of ague. The rigors do not differ from those occurring in other diseases, but they are very severe, and usually followed by profuse sweating. Between the rigors the temperature may fall to the normal, but more commonly remains above it. The skin is hot and soon develops an earthy or dull yellow tint, together with erythematous or petechial patches. A sweet, mawkish, hay-like smell of the breath is very characteristic.

Symptoms of grave depression supervene, and the patient rapidly wastes. The pulse becomes soft and weak, the excretions are diminished, and a certain amount of nocturnal delirium is noticed, but no loss of consciousness. The presence of a bruit in the precordial region may suggest the existence of an infective endocarditis, which is not very uncommon. The tongue varies, but is often red with very prominent papillæ, and becomes dry and brownish. Towards the end of the first week secondary abscesses appear, they are sometimes unaccompanied by local pain or tenderness, and form very rapidly, thus, a knee-joint may fill with pus in the course of a night of quiet sleep. They are, as a rule, small and numerous, if they occur in vital organs, death may result from their local development. When situated in the subcutaneous tissues, they are characterized by the almost-total absence of a barrier of granulation tissue, and hence, even when opened early and aseptically, are likely to extend and continue secreting pus, instead of following the usual course of rapid repair which succeeds the aseptic opening of an ordinary acute abscess.

Not uncommonly in these cases painful patches occur here and there in the subcutaneous tissues, accompanied by hyperæmia, which fades away after a few days, such are probably due to the impaction of small infective emboli, which the patient has sufficient vitality to get rid of without suppuration.

In Chronic Pyæmia the febrile symptoms are much less marked, the abscesses are few in number, and not dangerous unless forming in important structures. Thus, a fatal result ensued from a single abscess which developed in the lateral ventricle of the brain of a patient who had no other symptom of pyæmia except an oscillating temperature. It followed an operation on a septic sinus leading to a kidney already disorganized.

The condition of the *wound* at the onset of pyæmia is always very unsatisfactory. It gapes open and presents an inactive surface, and any newly-formed scar tissue readily breaks down. A layer of healthy granulations is an almost certain barrier against the occurrence of pyæmia, on account of the germicidal power of its constituent cells. If the disease arises in connection with bone, the latter structure is usually seen lying bare at the bottom of the wound, denuded of its periosteum, and the cancelli filled with sloughy foetid medulla or pus.

The *duration* of a case of pyæmia is very variable. Acute cases usually last a little over a week, whilst the subacute forms may run on for three or four weeks, and chronic cases continue for months and not unfrequently end in complete recovery.

**Post-mortem Appearances**—1 The appearance of any external wound has already been described. 2 The veins leading from it may be in a healthy condition, but are more commonly in a state of septic phlebitis, the coats are thickened, and the lumen is filled with soft, disintegrating clot, which extends for a considerable distance, the tissues surrounding the vein are also involved in the suppurative process. 3 Secondary abscesses are found in various parts of the



body, most frequently in the lungs, and their different stages can be clearly demonstrated from the embolic colonies of micrococci, through the stage of hæmorrhagic infarction to the complete abscess. The contained pus may be of the normal type, or thin and oily, it is always, however, swarming with cocci. 4. The general signs common to all cases of septic poisoning (p. 78) will also be manifest.

The **Diagnosis** of pyæmia should not be difficult in the majority of cases, but when it originates without any obvious external wound from a deep seated focus, or if the importance of some local lesion has not been appreciated, the initial symptoms may be mistaken for those of acute rheumatism or ague.

The **Prognosis** depends upon the inherent vitality of the patient and the virulence of the disease. In acute cases it is extremely grave, whilst in the chronic type recovery is not only possible, but probable, if the local abscesses are favourably situated.

In the **Treatment** of acute pyæmia the surgeon is acting at a considerable disadvantage, in that the disease is only recognisable when it has obtained some hold upon the patient, since the recurrent rigors, by which it is known, are usually the evidence of a grave general infection of the blood.

**Local** treatment is most important, and since the disease is in the majority of cases due to the detachment of infected emboli from a vein, the ideal surgical practice consists in preventing, if possible, the further contamination of the general blood-stream. This can sometimes be accomplished, in the case of a limb, by amputation well above the local lesion, or if the medullary cavity of a bone is the source of trouble, it may be possible to scrape out the gangrenous and offensive medullary tissue, and disinfect the cavity with pure carbolic acid, or if it is due to a wound in the soft parts, it may be feasible to dissect out the implicated vein and surrounding tissues, or at any rate to remove the disintegrating clot after placing a ligature upon the vessel between the thrombus and the heart. A typical illustration of such treatment is that adopted for septic thrombosis of the lateral sinus complicating disease of the middle ear, where, after tying the internal jugular in the neck, the sinus is exposed by the trephine or gouge, opened, and all the septic clot removed, partly from above, partly from below. Admirable results have been thereby obtained. The *abscesses* must be dealt with, where practicable, by opening them early and washing them out, such wounds often heal well, and joints which have been distended with pus may recover with free mobility. Occasionally, however, although rigid asepsis has been maintained, the suppuration continues, and even sloughing of the abscess wall may follow. If the general condition can be improved, a barrier of granulation tissue will form in time, and repair be established.

**Constitutional** treatment consists in supporting the patient's strength by nourishing diet and stimulants, and in taking precautions to avoid bedsores or any local injury. *Salicylate* of quinine may be administered, though its value is doubtful. The antistreptococcic serum may also be utilized, and it may do good in cases which have not progressed too far.

## CHAPTER V

### ULCERATION

ULCERATION has been defined as the 'molecular or particulate death of a part,' by which is meant the disintegration of the superficial tissues, which liquefy and disappear, and usually without any obvious slough. It differs from gangrene in that the latter term is used to denote the simultaneous loss of vitality of a considerable portion of tissue. The two processes are, however, often closely associated—in fact, both signify tissue necrosis, in the former the dead particles are not always visible to the naked eye, whereas in the latter the necrotic portions, if superficial, can always be seen.

Three main classes of ulcers are met with in surgical practice.

I *Ulcers due to traumatism or to non-specific pyogenic bacteria, e g*, the spreading, healing, chronic, etc.

II *Ulcers due to specific bacteria, e g*, soft chancre, lupoid, tuberculous, syphilitic, etc.

III *Malignant ulcers, e g*, rodent, epitheliomatous, scirrhus, and fungating.

**Causation** —Ulceration is due to the application of an irritant to the surface of such an intensity and for such a period as to lead to local inflammation, resulting in the destruction of the tissue affected. Any form of irritant, whether chemical, thermal, mechanical, or infective, may accomplish this end, and all the factors predisposing to inflammation will hasten its occurrence. Thus, faulty nutrition, whether from anæmia or from long-standing congestion, is particularly liable to further the ulcerative process. Moreover, when any part becomes anæsthetic, or is cut off from its trophic centres, the continued presence of an irritant may not be appreciated, and hence destructive inflammation occurs, *e g*, corneal ulcer following section of the fifth nerve, or perforating ulcer of the foot in tabes. In malignant disease the projection of the mass of the growth may expose it unduly to irritation, but the chief cause of ulceration is the replacement of the deeper layers of the skin or mucous membrane by the cells of the neoplasm, so that when the superficial epithelium wears off or is lost, it cannot be reproduced.

## I Ulcers due to Traumatism or to Non-specific Pyogenic Bacteria

**Clinical History** —Every ulcer of this class tends sooner or later to recovery, and so may be said to pass through three stages, viz, (1) that of ulceration proper, or extension, (2) a stage of transition, or preparation for healing, which may be short or long, according to whether the ulcer is running a rapid or a slow course, and persists until the surface is covered with granulations, and (3) the stage of healing or repair. It must be clearly understood that the first stage alone represents the true ulcerative process, when this ceases, the ulcer proper disappears, and merely a superficial loss of substance, the result of the preceding ulceration, remains. If every simple ulcer passes through these three stages, then *every variety of simple ulcer must necessarily be in one of the three stages*, and hence may be described as a modification of a typical condition representing the stage to which it belongs. Naturally, in a large ulcer the three stages may co-exist, or a healing ulcer may from intrinsic or extrinsic causes relapse again to the stage of tissue destruction.

**Stage I Ulceration Proper, or Extension** —The special characteristic of this stage is that destructive changes are progressing with greater or less rapidity, and hence the ulcers may be described as inflamed, spreading, or sloughing.

**Naked-eye Appearances** —*Surface*, covered with ashy gray or dirty yellow material, partly slough, partly lymph, partly breaking-down tissue, no granulations are present, the tendency to slough is most marked when the organisms are particularly virulent, or if the resistance of the tissues is much diminished, *discharge*, considerable in amount, thin, sanious, and often irritating and offensive, rarely purulent, *margins*, thickened and inflamed, and the surrounding tissues often œdematous and infiltrated, *edge*, sharply cut and well defined, the *base* of the ulcer is thickened and fixed to the underlying structures.

**Microscopically**, all the phenomena of inflammation may be observed progressing to thrombosis and tissue necrosis, so that in approaching the surface from the healthy tissues one would pass through zones of active hyperæmia, of retarded blood-flow with infiltration of leucocytes and plasma, of stasis and thrombosis, whilst the tissues are in a state of coagulation necrosis.

**Treatment of First Stage** —This resolves itself into removing the cause, protecting the surface from all sources of mechanical irritation, and purifying it from all septic contamination. The inflamed part must be kept at rest, and if necessary raised from a dependent position (*i.e.*, the leg must not be allowed to hang down), whilst the sore is dressed with moist and warm antiseptic applications, such as a boracic poultice. When the parts are very offensive, a charcoal and linseed-meal poultice may be first employed. The state of the bowels and constitution must be attended to, and probably a mild purgative will be needed.

**Stage II The Transition Period** comprises all the changes which occur from the termination of the ulcerative process proper to the time when healing is fully established by the wound becoming covered with granulations. In short, it may be described as the stage of *preparation for healing*.

**Naked-eye Appearances** — When the destructive process has ceased, and the septic element has been eliminated, the surface of the ulcer begins to clean, and becomes, as it were, glazed over, sloughs and portions of dead tissue are either removed in the dressing or absorbed by the activity of the leucocytes and fibroblasts. The discharge becomes less abundant and more serous in character, and the angry red blush is replaced by a rosy hyperæmia. The infiltration of the base also diminishes, so that the tissues around are less fixed and more supple. The film on the surface becomes more and more defined, and in the course of time, shorter or longer, according to circumstances, little red spots make their appearance here and there, these gradually increase in number and size, and coalesce, until the whole surface is covered by what has now become granulation tissue. The processes occurring in this stage are (a) the removal of the sloughs, (b) the covering of the surface with a cellulo-plastic exudation, and (c) the vascularization of this newly-formed material, and its conversion into granulation tissue.

**Microscopic Appearances** — When the action of the irritant has ceased, the migration of the leucocytes lessens, and the destruction of tissue comes to an end. The surface of the ulcer is now covered with a layer of small round cells resembling lymphocytes in appearance, plasma cells, and cells formed by the proliferation of the neighbouring connective tissue elements, and the superficial ones intermixed with fibrin in such a way that the cells lie in the interstices of the fibrillæ, this constitutes the film mentioned above. The vessels in the area, where merely stasis has occurred, become patent, and the circulation in the neighbourhood of the ulcer is thus restored. The vascularization of this superficial film is next undertaken, according to the process described in Chapter IX. The wound thus becomes covered with granulation tissue, and with its formation the processes included in the second stage come to an end.

*All the forms of chronic ulcer which are neither spreading nor actively healing may be included in this transitional stage, viz., the indolent or callous ulcer, the irritable, the varicose, etc.*

**The Indolent or Callous Ulcer** occurs most frequently on the legs of women about the middle period of life. The size varies greatly, but they are sometimes so extensive as to involve the whole circumference of the limb. It may also follow large burns on any part of the body, healing proceeds to a certain extent, and then stops from the fact that the contraction of the cicatricial tissue already formed interferes with the vitality of the part still unhealed by compressing the vessels, and so cutting off the granulations from their source of nutriment. The *surface* is usually smooth and glistening, and of a dirty yellow colour, with perhaps a few badly-

formed granulations the *edges* are hard and sharply cut, and elevated considerably above the surface, whilst the skin around may be heaped up over the edge, and either covered with sodden cuticle or congested. The skin of the limb is often deeply pigmented from chronic congestion, the pigmentation starting in the separate papillæ as maculæ, which gradually coalesce. The *discharge* is purulent or serous, and may be so abundant and irritating as to cause eczema of the parts around, and thus give rise to one form of *eczematous ulcer*. The *base* is adherent to the underlying tissues, fasciæ, etc., and this constitutes one of the main difficulties in healing, as contraction of the sore is thus prevented. If the ulcer extends to the periosteum, as happens not unfrequently when placed over the shin, chronic periostitis, or even osteitis, results, and a subperiosteal node is formed, corresponding exactly to the size and situation of the ulcer, forming a mushroom-shaped projection, and possibly going on to necrosis, or to enlargement of the whole bone. In some very chronic cases the superficial lymphatics and veins are so much compressed as to cause chronic œdema of the foot, often of a very solid, brawny type, and the limb may even pass into a condition of pseud-elephantiasis, preceded perhaps by recurring attacks of lymphangitis.

The so-called **Irritable Ulcer** is usually met with in this stage. Its chief peculiarities are the position, generally in the neighbourhood of the ankle, and the pain which accompanies it. The surface of a healing or chronic ulcer can usually be touched without the patient complaining, but in this variety the pain is excessive, especially at night. It was pointed out by the late Mr Hilton that, if a probe is run lightly over the surface of such a sore, one or more spots will be indicated as the chief seats of the pain, the rest being insensitive. In all probability, nerve filaments are there exposed, as the pain has a very marked burning or shooting character.

The **Varicose Ulcer** occurs in the leg of a patient who is the subject of aggravated varicose veins. The skin becomes passively congested, and its nutrition is consequently impaired, any injury or abrasion, which would readily heal in a sound limb, is likely under such circumstances to give rise to a chronic sore. Again, it may be preceded by eczema resulting from the irritation of dirt or the friction of hard trousers, whilst occasionally it may be due to the yielding of the thinned skin which forms the only covering of a much dilated vein, an accident often leading to severe hæmorrhage. The characters of a varicose ulcer vary considerably, but in the main correspond to those of the second or transitional period, it is usually found on the inner and lower portion of the leg, whilst syphilitic sores are more often placed nearer the knee and on the outer side.

The **Treatment** of ulcers in this stage differs according to the conditions present. If it is merely a passing phase in the progress of an ulcer tending rapidly to repair, all that is needed is to continue the same course of treatment as was adopted at an earlier period of the case, viz, rest and protection from irritation. It may be

advisable to shield the surface from contact with dressings by the intervention of a small portion of purified 'protective'—*i.e.*, oiled silk coated with dextrin—so that the reparative material may not be damaged during their removal

The **Chronic Ulcer** needs much care in its treatment, and some cases require operative interference. Rest in a more or less elevated position is absolutely essential in order to relieve the congested condition of the limb, whilst if the surface is foul, a charcoal poultice may be beneficial, or the sore may be dusted over with iodoform, and boracic fomentations applied. This may be preceded in some cases by touching the surface with nitrate of silver, or with a solution of chloride of zinc (40 grains to 1 ounce)

*Pressure* has been found of considerable service in the treatment of these ulcers, an ordinary bandage, reaching from the toes to the knee, will suffice in some cases, a suitable dressing of boric acid ointment, with perhaps some resin ointment added to make it more stimulating, being applied beneath it. *Martin's* indiarubber bandage is more useful when the veins are much enlarged

The method of dealing with chronic ulcers suggested by Professor *Unna*, of Hamburg, has given excellent results. It consists in the use of an adhesive plaster, made up as follows. Gelatin, 5 parts, oxide of zinc, 5 parts, boric acid, 1 part, glycerine, 8 parts, water, 6 parts, to this ichthyol (5 per cent) may be added with advantage. The limb is first thoroughly washed with soap and water, and purified with carbolic or sublimate lotion. It is then wrapped round with a single layer of antiseptic gauze, and the paste, liquefied by placing it in a gallipot in a saucepan of boiling water, is applied over it with a paint or paste brush. Another layer of gauze is placed over the paste and a thin bandage over all, and the whole allowed to dry. Where there is much varicosity of the veins, the paste should extend from the ankle to the knee, the foot being also included in some cases. If there is much discharge, the ulcer should not be covered, or the dressing should be reapplied in a day or two, but after it has diminished in amount, the paste may be carried right over the sore, and the whole application left in position for a week, or even longer

When the edges are very indurated and thickened, and all action is at a standstill, *Syme's* suggestion may be followed, *viz.*, the whole surface, as well as the surrounding skin, is blistered, and then a suitable dressing applied. A more satisfactory method, but requiring an anæsthetic, is to thoroughly scrape the surface with a sharp spoon, and then to rub in a strong solution of chloride of zinc. As soon as healthy action is established, skin grafting may be employed, if necessary, it is useless to undertake this, however, unless the patient can promise to rest up for a prolonged period, and even then elastic support will be subsequently required. In bad cases where a considerable portion of the circumference of the limb is involved, when the ulcer is very callous and its base attached to the tibia, causing severe pain at night from chronic periostitis, and especially

when the patient is unable to indulge in much rest, *amputation* may be the best treatment. It will often be found that Farabœuf's amputation at the site of election can be undertaken with advantage.

Where varicose veins exist, treatment is of little avail unless these are efficiently dealt with either by operation or by some suitable support, such as Unna's paste. If operation is needed, it is often undesirable to attack the veins locally owing to the septic condition of the ulcer. It may suffice to perform a Trendelenburg's operation (*qv*), or to make a circular or semicircular incision round the leg at the level of the garter, and dissect away all the superficial veins that can be reached through it.

The **Irritable Ulcer** may be treated by discovering the painful spots, and incising the tissues just above them with a knife, so as to divide the exposed nerves, but thorough scraping under an anæsthetic is preferable.

The **Eczematous Ulcer** must be dealt with differently from the others, or the eczema will be aggravated. Soothing applications are needed, such as lead lotion, and when once the acute stage has passed, tarry preparations (liq. carbonis detergens, 1 ounce to 1 pint of lotio plumbi), or an ichthyol ointment (5-10 per cent), may be beneficially employed. A mixture of benzoate of zinc and boric acid ointments is a very useful application, or Unna's paste with ichthyol may be utilized.

**Stage III** Repair having now been fully established, we have to deal with, not a healthy ulcer, for such a condition cannot exist, but a healthy granulating wound, the result of ulceration, or, as we call it, to avoid confusion, a 'healing ulcer'.

A **Healing Ulcer** is characterized by the following conditions. *Surface*, smooth and even, shelving gradually from the skin, and covered with healthy granulations, these present a florid red appearance, are painless, and bleed, but not readily, on being touched. The *discharge* varies according to the plan of treatment adopted. If the surface is kept at rest and free from all irritants, either septic or antiseptic, the discharge is merely serous, but should the wound become septic, or be dressed with irritating antiseptics, ordinary pus is formed. The surrounding skin is soft, flexible, and free from inflammatory congestion, and the *base* is similarly free from fixity. The *margins* present a healing edge, which has been described as manifesting three coloured zones: within is a *red* area consisting of granulation tissue, covered by a single layer of epithelial cells which cannot be seen except in a good light, next comes a thin dusky purple or *blue* line, where the granulations are covered by a few layers of epithelium, and the circulation is becoming retarded owing to cicatricial development, whilst outside is a *white* zone due to the heaping up of sodden cuticle upon the healthy or healed part.

The method of repair in such a wound consists in a change of the deeper layer of granulations into fibro-cicatricial tissue, which gradually contracts and is finally covered with epithelium. For full description see Chapter IX.

Occasionally if emollient applications are used too freely and too long, the granulations become pale, protuberant and cedematous, and the healing process is temporarily checked. A depressed general condition of the patient, or a varicose condition of the veins, may also account for this, and the term a *weak ulcer* is applied to it, whilst the prominent flabby granulations are popularly known as *proud flesh*.

The **Treatment** of a healing ulcer is simple in the extreme. All that is needed is to guard the surface from irritation, and Nature will rapidly bring about a cure. The part must be kept at rest, and if the leg is the seat of the trouble, it should not be allowed to hang down. The wound is dressed with any simple unirritating antiseptic, and perhaps boric acid lint is as good as any, a piece of protective, the exact size of the sore, may with advantage be interposed between the lint and the wound, or boric acid ointment may be spread on the lint. If the granulations become too prominent, they may be lightly touched with nitrate of silver, and a more stimulating lotion applied, such as that known as *lōtio rubra* (℞ *Zinci sulphatis*, gr 11, *tinct lavandulæ* co, *spir rosmarini*, āā ℥ x, *acid boricæ*, gr x, *aquam destill* ad ʒ 1).

Large ulcers require some assistance in order to obtain expeditious healing, otherwise a time comes when the contraction of the cicatricial tissue interferes with the nutrition of the granulations, and retards the healing process. Various plastic operations have been adopted to obviate this difficulty, and also the different methods of **skin-grafting**.

**Skin-grafting**, or the transplantation of more or less of the thickness of the skin from a healthy to a healing part, was introduced by Reverdin in 1869, and has since been much elaborated. The following are the chief methods employed.

1 Transplantation of small pieces of the cuticle and cutis, Reverdin's original plan. A small portion of the cutaneous tissue is pinched up with or without forceps, and removed by a pair of sharp curved scissors. In thickness it should include the cuticle and a portion of the cutis vera, so that a drop or two of blood will slowly ooze from the denuded surface. The graft is placed cutis downwards on the surface of the granulations and covered with protective, purified in boric acid. Many of these may be applied at the same time, and the whole wound carefully dressed and protected. If there is much discharge, the grafts will not 'take', but if the wound is merely discharging serum, there should be no difficulty in getting them to grow. Usually they disappear for a day or two, from the cuticle becoming softened or disintegrated, but soon the epithelium of the cutis spreads, and makes itself visible as a distinct centre of repair. The greatest gentleness is needed in handling the graft, as it readily perishes.

2 Transplantation of large portions of cuticle as suggested by **Thiersch**. This method consists in removing wide strips of cuticle with a razor, and implanting them on a fresh wound or on a raw



surface previously denuded of all granulations. The ulcerated surface is first scraped, and the resulting hæmorrhage stayed by pressure with a sponge, a layer of protective being, however, interposed, so that when the sponge is subsequently removed the bleeding shall not recur. The strips of cuticle are then cut, care being taken to make them as thin as possible, the papillæ are always encroached on, however, and hence some amount of blood escapes, in which the grafts are allowed to remain soaking until required for use. When it is thought that sufficient material has been obtained, the sponge and protective are removed, and the grafts gently transferred, being applied in such a way that they overlap each other and also the margins of the defect. There is always some tendency for the edges of the graft to turn in, and this must be prevented. They are then covered with protective, or preferably with perforated tin or thin silver-foil, and the whole dressed antiseptically. There is usually no need to look at the wound for some days. The outer sides of the thigh and arm are the best places from which to take the grafts. By this method subsequent contraction is to a large extent prevented.

3 The whole thickness of the skin is used in some instances. Thus, the preputial tissue removed in circumcision is most valuable for this purpose, being soft and flexible. All redundant and fatty tissue must be removed, and *only* the skin applied. The granulations should always be previously scraped away, and the graft stitched down to the underlying cicatricial tissue with fine catgut. It may also be applied to the raw surface of an operation wound.

## II Ulcers due to Specific Bacteria

The different forms of infective ulcers met with in surgical practice will be described under the appropriate headings in different parts of the book. It will suffice here to mention them.

**Soft Chancre** (p 136)—This may be taken as a type of all infective ulcers, clearly showing the stages of infection, incubation, ulceration, and repair.

### Ulcers due to Syphilis

- (a) The primary sore (p 139)
- (b) Secondary ulcers, mainly of mucous membranes, but sometimes involving the skin, and due to the breaking down of so-called tubercular syphilides (p 143)
- (c) Intermediate, rupial, or ecthymatous sores (p 146)
- (d) Tertiary ulcers from the disintegration of gummata, either superficial and multiple, or deep and single (p 148)

In inherited syphilis, any or all of the above varieties may be seen, except the primary sore.

*Phagedenic ulceration* (p 141) is usually associated with syphilis, but whether the phagedena is itself due to a specific organism is a little doubtful.

### Ulcers due to Tubercle

- (a) The lupoid ulcer, due to a cutaneous tuberculosis (Chapter XVI), or

- (b) The tuberculous ulcer, arising as a rule from the bursting of a subcutaneous or submucous tuberculous abscess (p 164)
- (c) Various other tuberculous ulcerative lesions of the skin are described by dermatologists under the title 'scrofuloderma,' whilst Bazin's disease (or erythema induratum) is possibly tuberculous in origin

**Malignant Pustule**, due to the *Bacillus anthracis* (p 127)

### III Malignant Ulcers

These are due, as has already been pointed out, ~~not to any inflammatory process~~, but to the actual replacement of the skin by the growth, so that loss of substance necessarily ensues. It is only requisite to mention the varieties here, a fuller description will be appended later (Chapter VIII)

(a) Rodent ulcer, a chronic cancer starting in the sebaceous glands or hair follicles, and accompanied with very little overgrowth

(b) Epitheliomatous ulcer, arising from cancer of the skin or mucous membranes

(c) Scirrhus ulcer, resulting from destruction of the skin over a scirrhus tumour

(d) Fungating ulcer, where a neoplastic growth protrudes from the skin. It may be caused by a soft encephaloid cancer, or a sarcoma, whilst a cystadenoma mammæ gives rise to a similar appearance. It constitutes the condition formerly known as a 'fungus hæmatodes'

## CHAPTER VI

### GANGRENE

By gangrene, or necrosis, is meant the simultaneous loss of vitality of a considerable area of tissue. If the process is limited to the soft parts of the body, it is often termed *sloughing* or *sphacelation*, and the dead mass a *slough* or *sphacelus*, if a tangible portion of bone dies, the necrosed mass is called a *sequestrum*, while the term *gangrene* is more especially applied to a necrotic process affecting simultaneously the hard and soft tissues of a limb.

#### General History of a Case of Gangrene

**Signs of Death**—Death of a limited portion of the body can be recognised prior to the supervention of evident post-mortem changes within it by five characteristic signs

- 1 Loss of pulsation in the vessels
- 2 Loss of heat, since no warm blood is brought to it
- 3 Loss of sensation, although much pain may be experienced whilst death is occurring, and such may be referred to the dead part through irritation of the nerves above
- 4 Loss of function of the gangrenous mass, which, if it is a limb, lies flaccid and motionless
- 5 Change of colour, the character of which depends on the amount of blood in the part at the time of death, if the limb is full of blood, it becomes purple and mottled, if anæmic, a waxy or cream colour results

These five signs may be in measure present when the vitality of a limb is seriously depressed, as by ligation of the main vessel or by its embolic obstruction, but if they continue for any length of time, death is practically certain to ensue, and they will then be rendered more obvious by the phenomena about to be described. Sometimes it is a little difficult to determine whether a part is dead, especially when it is engorged with venous blood and the arterial pulsation has ceased, if living, it will usually be found that pressure causes some modification of the colour, and that the discoloration returns when the pressure is removed.

**Changes occurring in the Dead Tissues**—The character of these changes depends mainly on the condition of affairs at the time of

death, and whether or not putrefaction supervenes. The following conditions are described

1 **Dry Gangrene** (= *death + mummification*) can only occur when the tissue involved is, previous to its death, more or less drained of its fluids, so that it readily shrivels up and loses its moisture. The usual cause is chronic arterial obstruction, as brought about by atheroma or calcification of the terminal arteries, to which a sudden or gradual complete occlusion of the main trunk is often superadded. The dead part becomes hard, dry and wrinkled, and is of a dark-brown or black colour from the diffusion of the disintegrated hæmoglobin (Fig 11). The more fleshy parts (*e g*, above the ankle) rarely undergo complete mummification, and are often considerably inflamed, and, if sepsis be admitted, horribly offensive.

2 **Moist Gangrene** arises when a part of the body full of fluid dies, and is especially associated with venous obstruction, or with acute



FIG 11 —SENILE DRY GANGRENE

arterial thrombosis in a previously sound limb, *e g*, in traumatic gangrene due to pressure upon, or rupture of, the main trunk. The loss of the *vis-a-tergo* derived from the heart's impulse causes a negative pressure in the capillaries, which become filled by regurgitation from the veins. Obviously, such a condition is well suited for the development of the organisms, which always exist in numbers on the skin, and unless the most vigorous efforts are made to render it aseptic before or immediately after death, moist gangrene is certain to be associated with putrefaction, but it must be clearly understood that the latter is no essential part of the gangrenous process.

**Aseptic Moist Gangrene** is characterized by the dead tissues becoming more or less discoloured, either purple or any shade from black to yellow, green or white. It remains of much the same size and consistency as at the time of death so long as it is kept from contamination, and is then simply and quietly cast off from the surrounding tissues without any obvious inflammatory disturbance, although a certain amount of toxæmia may result from the absorption of various products from the dead tissues.

Septic or Putrid Moist Gangrene (Fig 12) is necessarily associated with a rapid breaking-up and disintegration of the mass, which becomes black, green, or yellow. The cuticle is raised from the cutis vera by blebs containing stinking serum, or even bubbles of gas, and these can be readily pressed along under the epidermis for some distance. The tissues of the limb are soft and lacerable, and on grasping it emphysematous crackling is usually noted.

The Later History of a gangrenous mass depends entirely on its asepticity or not, and on its bulk.

(a) If the necrotic area is small in size and aseptic, it may, under favourable circumstances, be entirely *absorbed* in the same way as is a catgut ligature. Such is often observed after sloughing of small portions of amputation flaps, if the part is kept dry and aseptic, it is gradually removed, and when the process is completed, a small dark scab will fall or be picked off, and a cicatrix be found beneath it. In a similar way dead bone may be absorbed, if the sequestrum is not too large or too dense, and if it is in close proximity to healthy

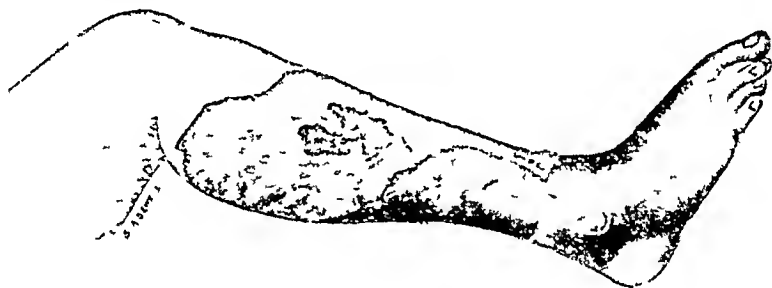


FIG 12—SEPTIC MOIST GANGRENE OF LEG FROM PENETRATING WOUND OF FEMORAL ARTERY

vascular tissue. The dead portion is first invaded by leucocytes from the lymphatic spaces or vessels of the immediately contiguous living tissues, and infiltrated by them and the accompanying blood plasma. By a process of auto-digestion this infiltrated portion disappears, and is replaced by granulation tissue (for the origin of which, see Chapter IX), which in turn is converted into a cicatrix, and covered with cuticle in the usual way.

(b) If the mass, though aseptic, is of such a size, or consists of such tissues, as to prevent its total absorption, or if the vital activity of the patient is lowered, a modification of the same process results in *partial absorption* of the dead material, whilst the remainder is cast off and separated by a simple process of anæmic ulceration. The dead part immediately contiguous to the living is removed and replaced by granulation tissue, and this change continues advancing into the mass until the layer of granulations which has penetrated furthest is at such a distance from its nutritive basis as to be unable to derive from it sufficient pabulum, owing to the contraction of the cicatricial tissue which is forming behind, and then a simple ulcerative process

from defective nutrition causes a line of cleavage to form between the living and dead, by means of which the latter is separated from the body. The size of the portion thus cast off is distinctly less than that of the original necrotic mass. Whilst this is occurring, there is no local inflammatory reaction, and but little resulting constitutional disturbance. It is slow in progress, but there are none of the risks attaching to the more rapid septic proceeding. Of course, the denser and harder the tissues, the longer they take in separating, and hence it is possible for the soft tissues of a limb to have separated, and the wound caused thereby to have cicatrized before much impression has been made on the bones. Considerable retraction ensues, giving rise to a conical stump from the apex of which the bone protrudes.

(c) If the gangrenous portion is septic, its *separation* is accomplished by a *distinctly inflammatory act taking place in, and at the expense of, the surrounding living tissues*. The extent of the gangrene is primarily indicated by a *line of demarcation*, due to the change in colour occurring in the dead part, the living tissues retaining their normal hue. The irritation of the chemical products formed in the necrosed mass causes inflammation in the surrounding structures, resulting in hyperæmia and subsequent exudation of plasma and leucocytes, the tissue of the part is replaced by a cell infiltration, which in turn breaks down into pus, whilst a layer of granulation tissue forms at the limit of the living portion, and thus the *final line of separation* is produced. Clinically, one notices in this latter stage a bright red line of hyperæmia at the extremity of the living tissues, which gradually spreads and deepens until about the eighth or tenth day, when, if the cuticle is intact, the living and dead parts are separated by a narrow white or yellow line, which is proved, on pricking the epidermis, to be due to the presence of a layer of pus, as the pus escapes, a shallow groove is seen running between a granulating surface on the side of the living tissues and the gangrenous mass. This process, gradually extending through the whole thickness of the limb, is accompanied by the local signs of inflammation and by fever, the degree of the latter depending on the amount of toxic material absorbed. The inflammation, moreover, is not always limited to the line of separation, but may spread upwards along the lymphatics or veins, or in the fascial and muscular planes, until, perhaps, the whole limb is involved in an extensive suppurative process.

The Constitutional Symptoms of gangrene may be described under two distinct headings.

(a) Those general conditions which predispose to the occurrence of gangrene, and which are mainly of a debilitating character, affecting either the composition of the blood or the vitality of the limbs. General diseases, such as diabetes and albuminuria, may be present, as also the constitutional results of a vicious life, whilst local evidences of malnutrition often manifest themselves before the onset of gangrene.

(b) Those conditions depending on the presence and connection with the body of the dead tissue Various forms of septic poisoning result, usually causing fever, asthenic in type and variable in amount Pain, moreover, is frequently a prominent feature in some forms of gangrene, and the patient is liable to become exhausted from this cause, even though he is protected by the surgeon's care from the dangers of sepsis

The Treatment of gangrene naturally divides itself into the local and general We shall not discuss the question of Local treatment at this place, leaving it to be dealt with under the appropriate headings hereafter As to General treatment, but little need be said beyond that the strength of the patient must be maintained by plenty of easily assimilable food, sufficient stimulant, and tonics Pain and sleeplessness must be combated by the administration of a suitable amount of opium or morphia, if the kidneys are healthy Diabetes and albuminuria need dietetic and therapeutic measures in order to limit, if possible, the excretion of sugar and albumen

### Varieties of Gangrene

The following classification is one which, though admittedly imperfect, does in a measure group together allied types of the affection, and will serve as a useful one for practical purposes

I **Symptomatic Gangrene**, or that predisposed to by preceding vascular or general conditions, where a trauma, if present at all, is of very slight significance

- (a) Gangrene from embolus
- (b) Senile gangrene
- (c) Gangrene from arterial thrombosis (non-senile)
- (d) Diabetic gangrene
- (e) Raynaud's disease
- (f) Gangrene due to ergot

II **Traumatic Gangrene**, which may be due to direct or indirect injury, and where the damage done to the vessels or tissues by the trauma is the immediate cause of the loss of vitality Two varieties of this may be met with, viz

- (a) The indirect, where the lesion involves the vessels of the limb perhaps some distance above the spot where the gangrene occurs
- (b) The direct, where the gangrenous process is limited to the part injured

III **Infective Gangrene**, which arises from the activity and influence of micro organisms

- (a) Acute inflammatory or spreading traumatic gangrene
- (b) Wound phagedena and hospital gangrene
- (c) Necrosis of bone (most cases)
- (d) Noma and cancrum oris
- (e) Carbuncle and boil

## IV Gangrene from Thermal Causes—frost-bite and burns

Each of these varieties must now claim separate and individual attention

## I Symptomatic Gangrene

(a) **Embolie Gangrene** (For general details as to emboli, see Chapter XIII) When the main artery of a limb becomes blocked by a simple embolus, the condition is exactly similar to that which obtains after ligature, and under ordinary circumstances should not lead to gangrene, but if either the general or local vitality is much reduced, the occlusion of the main trunk may be sufficient to determine the death of more or less of the limb. Thus it may occur

(1) Where the embolus consists of a fibrinous vegetation detached from one of the cardiac valves in a case of endocarditis following



FIG 13 —GANGRENE OF FOOT AFTER EMBOLIC OBSTRUCTION OF POPLITEAL ARTERY

rheumatic or other fevers. The general nutrition has been depressed by the preceding fever, the heart's action is weak, and the circulation possibly impeded by the valvular lesion, so that the occlusion of a main trunk, even in a young person, is often sufficient to determine gangrene. (11) It also follows when a detached atheromatous plate blocks the main vessel of a limb previously rendered anæmic by arterial degeneration, an occurrence not unusual in elderly people.

Emboli are most commonly arrested at the sites of division of the main trunks (Fig 14, A), or where the calibre is suddenly diminished by the origin of a large branch, the embolus often saddling over the bifurcation, and thus, as it increases in size by the subsequent deposit thereon of fibrin, effectually closing both branches (Fig 14, B). In the lower limb it occurs at the division of the femoral or popliteal, in the upper, at the origin of the superior profunda, or where the brachial divides.



The chief early **Symptom** is pain experienced both at the point of impaction and also down the limb along the course of the vessel. Pulsation below the block ceases, sensation and temperature diminish, and the part feels heavy and useless. If the vessels are healthy, stagnation of blood in the veins is an early result, the terminal portion of the limb becoming congested and œdematous, and finally passing into a condition of moist gangrene. If, however, the terminal arteries are calcified or atheromatous, so that the limb is in a state of chronic anæmia, dry gangrene is likely to follow. The process starts peripherally, and spreads gradually upwards until it reaches a level where there is sufficient circulation to maintain the life of the part. Such usually obtains in the neighbourhood of a joint, since there is always a more free anastomosis here than in the interarticular portions of the limb, thus, in the leg the gangrene is arrested either

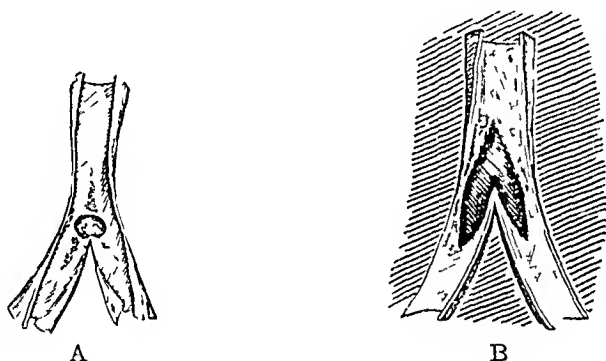


FIG 14 — DIAGRAMS OF EMBOLUS SADDLING THE BIFURCATION OF AN ARTERY

In A the embolus is seen, and the commencement of a thrombus on it, but not yet obstructing the vessel, in B both branches of the trunk are blocked by the growth of the clot

immediately above the ankle or below the knee. The subsequent history depends upon whether or not the dead tissue is allowed to become septic, and requires no special notice.

**Treatment** — The all important requisite is to prevent the advent of sepsis, even before any absolute signs of death are manifest. The nails should be cut, and the whole limb thoroughly purified (Chapter X), special attention being directed to the intervals between the toes and the semilunar folds of the nails. It should then be wrapped in a sterilized dressing, and lightly, though firmly, bandaged. The limb is kept slightly raised so as to assist the venous return without interfering with the arterial supply, and by this means gangrene may be prevented. If, however, gangrene ensues, the same measures as to the maintenance of asepsis must be continued until a natural line of separation forms. In old people with dry gangrene similar rules are followed as for the senile type, but in the moist form, occurring in young people, the natural process of separation may be hastened by severing the dead from the living and sawing through the bone, or

possibly amputation through the living tissues a little above may be considered advisable, a more shapely stump being thus obtained. Where sepsis has occurred, it is wise to amputate through healthy tissue as soon as the gangrenous process has finally ceased to extend. If, however, spreading septic inflammation exists, one may be driven much higher up the limb than would be otherwise necessary, and this even before any line of separation has formed.

(b) Senile Gangrene occurs in elderly people, and is the result of imperfect nutrition of the tissues. The toes are most frequently affected, but it is also seen in the hand, and may attack the nose, ears, or even the tongue.

**Causes**—These are to be found mainly in the condition of the circulatory organs. (a) Calcareous degeneration (Chapter XII) of the smaller arteries of the limb or part is always present, as also possibly atheroma of the larger trunks. The vessels in consequence become pipe-like and inelastic, and incapable of accommodating themselves to the requisite variations in the blood-supply. Hence a fixed minimal amount of blood enters the limb, which passes into a chronic state of anæmia and malnutrition, whilst the tunica intima is often so rough as to predispose to thrombosis with or without injury. (b) A weak heart is generally present, leading to low pulse tension, and increased difficulty in propelling the blood through the rigid and narrowed vessels, and (c) the condition of the blood may be impoverished by albuminuria. When such predisposing factors are present, anything that results in (d) thrombosis either in the main trunks or in the peripheral arterioles or capillaries is likely to determine the onset of gangrene. Thrombosis of the main vessels may be due to a blow or strain, which often passes unnoticed, or more frequently arises from a gradual deposit of fibrin on the already roughened walls. If the obstruction originates in the smaller trunks or capillaries, it is generally brought about by some slight injury, such as striking the ball of the great-toe against the table, or even cutting a corn. Exposure to cold may also act as an exciting agent. In either case the clotting extends for some distance, and the height to which the gangrene spreads will vary accordingly.

**Symptoms**—Evidences of malnutrition of the limb will probably have been noticed for some time in the form of cramp and pain in the muscles, which become fatigued rapidly, whilst sensations of pins and needles or numbness are also experienced. The circulation in the tibials may be so slight as to be scarcely perceptible, and the whole limb feels cold and heavy. The skin is often passively congested, and hence prone to low forms of ulceration or eczema. When the gangrene commences as a result of some peripheral lesion, an area of painful redness is first noticed, perhaps running on to ulceration, and in the centre of this patch a slough forms, which becomes dry and black. The process gradually spreads from this focus with more or less inflammation, so that it is sometimes known as inflammatory senile gangrene. If, however, it results from thrombosis of the main vessels, death occurs without the supervention of local

inflammatory phenomena, the toes merely shrivelling up and dying (*non-inflammatory senile gangrene*) The inner side of the great-toe is perhaps the commonest situation for the mischief to start, and thence it spreads from one toe to another, and also along the instep and up the ankle to the leg *Pain* is always a marked feature, whilst the extent of the gangrene is dependent partly on the amount of general and local vitality, and partly on the asepticity or not of the surrounding tissues As the disease spreads, the patient becomes exhausted by the long-continued pain and want of sleep, and septic fever, bedsores, or the intervention of some cardiac, pulmonary, or renal complication, may also hasten a fatal termination

The **Treatment** adopted until recently was governed by the observation that after any attempt to amputate through *neighbouring* living parts the gangrenous process is certain to commence again in the flaps; if merely cutting a corn suffices to originate the malady much more does so severe an injury as an amputation The parts were dusted with iodoform or some similar antiseptic, and wrapped in cotton-wool to keep them warm, the surgeon waited for a line of separation, and even then merely assisted Nature by dividing tendons or bones The general health was maintained by suitable nourishment, stimulants and tonics, and pain alleviated by opium In spite of every care, however, the enfeebled constitution of the patient was often unequal to the task of ridding the body of the dead mass, so that death from exhaustion or blood-poisoning was the rule rather than the exception, and even if he did recover, the prolonged illness considerably diminished his vital powers

It has now, however, been clearly demonstrated that *early amputation well away from the dead mass* at a point where the blood supply is sufficient to nourish the flaps, and yet not so near the trunk as to seriously threaten life through shock, holds out the best prospects of relief In order to determine the most favourable site, the pulsation in the main artery should be felt for, and if feasible no operation performed at a spot where it appears to be occluded The condition of the limb will also influence the surgeon's decision, if thin, attenuated, and shrivelled, it will be wise to amputate high, but if the limb is fairly well nourished and with plenty of adipose tissue, the operation may be performed somewhat lower In operating, as little damage as possible should be inflicted on the parts, the flaps being nearly equal in length and not too flimsy, a circular amputation, or some slight modification of it, being perhaps the best In cases where the mischief is limited to the foot, it is usually advisable to amputate through the lower third of the thigh, or at any rate in the neighbourhood of the knee-joint, though not through the joint itself, as the flaps in that operation are always rather flimsy We have followed this line of practice for some years, and have no reason to be dissatisfied with our results Dissection of the portions removed has always shown that the vascular trouble was fully as advanced as we had anticipated, and that no minor measures would have sufficed

(c) **Gangrene from Arterial Thrombosis (non-senile)** is not a common occurrence. It arises as a result of that curious affection *endarteritis obliterans*, and also develops in some young people in scattered patches about the skin without any of the characteristic phenomena of Raynaud's disease. It sometimes occurs in connection with typhoid fever and other conditions of severe toxæmia as an outcome partly of the increased coagulability of the blood, partly of a localized endarteritis, due to the toxins present in it. The femoral artery is most usually blocked, but occasionally the trouble will spread up to the aorta and involve both legs in the gangrenous process. Unless the vein is also involved, the gangrene is usually of the dry type. It is wise to wait until a line of demarcation has formed, and then amputate well above.

(d) **Diabetic Gangrene** is mainly due to the abnormal condition of the blood in diabetes, thereby reducing the power of the tissues to



FIG 15 —DIABETIC CELLULITIS AND GANGRENE OF FOOT

resist bacterial invasion, but it is also in measure the result of a sclerosing endarteritis and peripheral neuritis. It is not commonly met with in the subjects of acute diabetes, nor, as a rule, in people below forty years of age. It results usually from some slight traumatic or infective injury, and often commences on the under side or at the extremity of one of the toes as a bleb, surrounded by a dusky purple areola. When the bleb is opened or bursts, the central portion of the underlying tissue is found to be necrotic, and from this focus the gangrene spreads. If the part is kept aseptic, and especially in limbs with some degree of endarteritis, the dead part may shrivel and dry up, especially when suitable dietetic restrictions are enforced, but if such local and general precautions are not observed, extensive suppurative infiltration of the soft parts may follow (Fig 15), even though the necrotic process itself be of slight extent, and from this the patient may succumb, the fatal issue being due partly to diabetes, partly to toxæmia, and being often preceded by coma.

**Treatment** —In the less severe cases, limited to one or more toes, it will often suffice to keep the part warm and aseptic, until it is

separated by natural processes, or at any rate the surgeon merely completes the work by dividing or dissecting out bones. Naturally, the elimination of sugar must be checked, if possible, by suitable diet and the administration of codeia. In more extensive trouble the character of the treatment turns largely on the amount of vascular disease and the degree of the accompanying inflammation. If the vessels are tolerably healthy, amputation not very much above the upper limit of the gangrene is justifiable, but if the main trunks are probably affected, a high amputation will be required, if the patient's general condition permits, although there is some risk that diabetic coma may supervene. When extensive suppuration is present, it is sometimes wise to lay the parts open for awhile and drain away the inflammatory exudations before considering the question of radical treatment.

(c) Raynaud's Disease, or Spontaneous Symmetrical Gangrene, is a condition usually met with in anæmic or neurotic young women between the ages of fifteen and thirty. It is due to vaso-motor spasm, dependent on some deep unrecognised lesion of the spinal cord, or in some cases to a peripheral neuritis. Three stages are usually described: (i) local syncope or anæmia, due to arterial spasm, and characterized by pallor and painfulness of the part, (ii) local asphyxia or congestion, the affected tissues being blue and cyanosed from venous regurgitation, and (iii) necrosis, the part becoming dry and black. The onset is often sudden, and the disease may last for a variable time, from days to months. If gangrene supervenes, the latter is the limit more often reached, but it by no means necessarily follows that tissue necrosis occurs in every case. The disease is usually symmetrical, and affects the fingers rather than the toes, but superficial patches may occur on any part of the body, the process is non-febrile and often very painful. Paroxysmal hæmoglobinuria has been observed, and is supposed to be due to vaso-motor disturbance of the kidneys. Ankylosis of the smaller interphalangeal joints and localized patches of anæsthesia, associated with neuralgic pain, are sometimes present, resulting from peripheral neuritis. The condition resembles the later stages of a chilblain, but is distinguished by its more dusky colour, the greater pain, the absence of itching, and the fact that the process is not limited to exposed or terminal parts, or to cold weather.

The **Treatment** in the early stages is directed to the prevention of gangrene. Iron, quinine, and other suitable tonics are administered, and menstrual irregularities are attended to. Friction with stimulating embrocations, warm douches, and protection from cold and injury, may be employed locally, but probably the best results will follow the use of electricity. The constant current is employed, and preferably in the shape of the electric bath, local or general as required, and repeated either once or several times a day. When actual gangrene is present, the dead tissue should be kept aseptic, when sooner or later it will be absorbed or separated.

(f) Gangrene from Ergot is a rare phenomenon, but it has been

known to occur when diseased rye has been used in the manufacture of bread. The resulting gangrene may vary in extent from the loss of one or two fingers or toes to the sacrifice of the greater portion of one or more limbs.

## II Traumatic Gangrene

By traumatic gangrene is meant the loss of vitality of some part of the body as the consequence of an injury, whether applied to the main bloodvessels (*indirect* traumatic gangrene), or directly to the tissues (*direct* traumatic gangrene).

(a) Indirect Traumatic Gangrene arises from a considerable variety of lesions, and the course and clinical history are similarly variable.

(i) Ligature of the main artery does not produce gangrene in a healthy limb, but should it be in a state of chronic malnutrition and anæmia from preceding arterial disease, death of a certain portion may ensue, the case running a similar course to one of gangrene due to embolus. It is usually of the dry type, and limited to one or two toes, but if it reaches the more fleshy portions, the moist variety supervenes.

Treatment consists in keeping the parts warm and aseptic until a definite line of separation forms, and then in assisting the natural processes at this spot by dividing tendons and bones. If, however, a considerable area of the limb loses its vitality, and especially if the dead tissue is moist and septic, an early high amputation is required.

(ii) Arterial thrombosis from injury only causes gangrene under special circumstances, the course and treatment being similar to that resulting from an embolus.

(iii) Obstruction to both main artery and vein is an almost certain precursor of gangrene. A few cases are on record in which both vessels have been ligatured, or even portions of them removed without such a result, as in dealing with cancerous deposits in the axilla or in the extirpation of aneurisms, but in both these instances obstruction to the circulation must have previously existed, necessitating the opening up of collateral anastomotic branches. In a normal limb the occlusion of both afferent and efferent trunks is practically sure to determine tissue necrosis. It may therefore be caused by the inclusion of both vessels in a ligature, or by the *strangulation* of organs, either within the body, as in a strangulated hernia, or outside of it, as when a ligature is tied round the base of the penis, or a bandage applied too tightly round a fractured limb. It may even result from the swelling of a limb under a bandage which has been originally applied with no undue tension.

A very similar effect may be produced by the excessive hyperæmia and exudation following the sudden relief of a tight constriction around a part, which has thus been deprived of fresh arterial blood for some time, the vessel walls are thereby so damaged that they are unable to resist the blood-pressure, and the exudation that follows is so abundant as to rapidly bring the circulation to a stand-

still Such an occurrence is met with after frost-bite, and also in a loop of bowel after strangulation

Gangrene may also result from the rupture of a main artery and compression of the accompanying vein by the extravasated blood, an occurrence perhaps most frequently seen after *fractures* and *dislocations*, it is then always of the moist type (See Chapter XIX)

**Treatment** varies considerably in these cases If the parts are hopelessly injured, amputation should be performed at once, so as to prevent the risk of sepsis In some fractures and dislocations with vascular lesions, it may be possible to save the limb by cutting down, turning out clots, and securing the injured vessels, whilst the bony lesion is dealt with in a suitable manner The limb should afterwards be elevated slightly, and the peripheral segment kept warm and aseptic Should gangrene supervene, amputation will be required, its situation depending on the character of the local lesion, if it is not of a serious nature—*e.g.*, a clean fracture or simple dislocation—it is wise to wait for a line of demarcation, but if comminution of bone or other grave local trouble is present, one would amputate above the injury

✓ (b) **Direct Traumatic Gangrene**, or that resulting from the immediate effect of injury to the parts, is similarly due to a variety of lesions

(1) **Severe crushes or blows** are a common cause of this type of gangrene, thus a limb may become mangled between the wheels of machinery, or by heavy weights falling on it, or by the passage of vehicles over it Not only are the parts crushed, severely contused, or even 'pulped,' but the bloodvessels may be torn, and the resulting extravasation contributes to the result The gangrene is of the moist type, and is more likely to supervene in patients whose vitality is diminished Thus, a crush of the foot in an elderly person is often followed by it, when in a young and healthy adult it could be prevented

**Treatment**—If the part is hopelessly damaged, operation should not be delayed on account of the dangers of sepsis, and therefore immediate amputation is recommended The question of shock and its influence in determining operation is discussed elsewhere When there seems a reasonable chance of saving the limb, it is cleansed and purified under the strictest antiseptic precautions, should gangrene supervene, it may be removed later

(11) **Prolonged pressure** is also capable of producing gangrene Gangrene from *splint pressure* is either almost unavoidable, or the result of carelessness When the fragments are much displaced after a fracture, considerable pressure may be required to retain them in good position, and then in spite of every precaution necrosis may ensue Pain of a neuralgic type is usually complained of for a few days, but even that is not necessarily severe enough to attract much attention, when the limb is freed later on, the dead portion of the skin is white, anæmic, and insensitive The necrotic process may extend to some depth, and hence the greatest care must be

taken to keep the dead tissues aseptic, thereby avoiding grave local and constitutional disturbance

*Bedsore*s are likely to occur in patients who are kept for a long time in the recumbent posture, or in any one particular position. The parts most exposed to pressure become red and congested, and finally ulceration or actual gangrene supervenes. Bedsore)s are not usually extensive or deep, but if the patient is debilitated, and especially if a condition of lowered sensation is present, due to impairment of the nerve-supply, as in paraplegia, the process may extend rapidly, destroying fasciæ, laying open muscular sheaths, and even leading to necrosis or caries of bones (*acute bedsore*). The spinal canal itself has been opened in this way, and death from septic meningitis has resulted. To prevent the occurrence of such sores, the most scrupulous attention must be given to the parts exposed to pressure. The nurse should see that the draw-sheet and bed-linen are placed smoothly and without creases, and that no contamination by urine or fæces is allowed, if the patient is perspiring freely, the sheet should be frequently changed, so as to prevent decomposition of the sweat. The skin of the back is daily examined, washed with some unirritating soap, and rubbed with a soothing, strengthening, and hardening application, such as spirit of wine, methylated spirit, or perhaps, better still, a mixture of brandy and white of egg. It is then dusted over with a mild antiseptic powder, such as boric acid. If the skin becomes red, it should be painted with collodion, or with a mixture of equal parts of tincture of catechu and liquor plumbi subacetatis, which when dry leaves a powdery film on the surface, and protected from pressure by means of a circular hollow water-pillow. Paraplegic patients or old people should at once be placed on a water-bed, which must be sufficiently, but not excessively, distended. If there is too little water, the weight of the body displaces it to one side, and no good results, whilst if there is too much, the bed becomes hard and resistant, and fails in the object for which it was employed. When an open sore forms, it must be kept aseptic, and dressed either with boric acid ointment, or in the more sluggish cases with resin and boric acid ointments mixed. Friar's balsam, mixed with castor-oil (1 part of the balsam in 8 of the oil), is useful in this condition.

(iii) The action of **corrosive or caustic chemicals** is followed by a localized traumatic necrosis, the degree of which varies with the amount and character of the irritant present, and the duration of its action. All that is needed is to keep the parts aseptic, and allow them to be absorbed or separated by natural processes.

A curious form of gangrene occasionally follows the application of a *carbolic acid* compress, even when weak solutions are employed. The fingers are the parts usually affected, and the gangrene does not seem to have been due to tight bandaging. Possibly the carbolic acid determined prolonged arterial spasm, and the anæmia was followed by local necrosis.



### III Specific or Infective Gangrene

(a) **Acute Spreading, Acute Emphysematous, or Spreading Traumatic Gangrene**—This disease is one of the most rapidly fatal and serious met with in surgery

**Causes**—(i) The *individual* attacked is often predisposed to infection as a result of vicious or careless living, heavy drinking, or simple malnutrition, but even healthy individuals may be attacked if the virus is particularly active. It is sometimes seen in diabetics, but an apparent glycosuria occasionally develops in the course of the disease

(ii) The *causative lesion* is usually severe, such as a compound fracture or dislocation, especially if the soft parts are much contused or very dirty. Less frequently it consists of small and insignificant pricks, scratches, or abrasions, if thereby a virulent organism gains access to the tissues. In this way post-mortem porters, nurses, or pathological demonstrators may become infected

(iii) An organism frequently present is the *Bacillus oedematis maligni*, which is identical with the *Vibrio septique* of Pasteur and the French writers. It is a rod-shaped organism, which closely resembles that of anthrax, but with a greater tendency to grow into long threads. It is actively motile, and forms oval spores, which may be placed at the centre or at the end of the rod. It does not stain by Gram's method. Cultures only develop under anaerobic conditions, and if the culture medium contains glucose, a large amount of foul-smelling gas is produced. It is usually very virulent for mice and guinea-pigs, which die within twenty-four hours of inoculation, locally a spreading oedema is produced, the connective-tissue spaces being filled with fluid containing bacilli, and perhaps air-bubbles. Bacilli are also found in the exudations which occur in the serous cavities, in the connective tissues of important organs, and in the blood for some time after death. The *B. aerogenes capsulatus* may also cause acute spreading gangrene. It is an anaerobe with a similar power of fermenting sugar, but it differs from the bacillus of malignant oedema in that it is non-motile, rarely forms spores, and retains Gram's stain. It usually forms a well-defined capsule, from which its name is derived, this, however, is not invariable. Careful investigation of fifty-eight cases\* of spreading gangrene demonstrated that in only fourteen cases was the infection pure, and that with an anaerobic organism, in forty-four cases the infection was mixed, various septic organisms being present in addition to the gas-producing microbe, which was more frequently the *B. aerogenes capsulatus* than the *B. oedematis maligni*. A special feature of infection with the former is the large amount of gas produced, not only in the tissues, but also post-mortem in the

\* See Corner and Singer on 'Emphysematous Gangrene,' *Trans. Path. Soc. Lond.*, vol. III, 1901, p. 42, Welch's 'Shattuck Lecture,' *Philadelphia Med. Journ.*, August 4, 1900

vessels, and notably in the liver, from which it can easily be squeezed, constituting the 'foaming liver' of some writers

The Symptoms are those of a hyperacute cellulitis, accompanied by general septicæmia. The wound early takes on an unhealthy action, the surface becoming covered with sloughs, and a thin serous or sero-sanguineous discharge escaping. The inflammatory process rapidly spreads along the connective-tissue planes of the limb, which becomes swollen, painful, and brawny. At first it is of a dusky purplish colour, but soon the signs of actual gangrene supervene, and the necrotic tissues become crepitant and emphysematous, partly from simple putrefaction, partly from the gaseous developments associated with the growth of the specific organism. Occasionally the emphysema spreads widely and rapidly, with at first no other local evidence of mischief, sloughing will, however, follow if the patient live long enough. Evidences of profound toxic disturbance, such as hyperpyrexia and delirium, soon manifest themselves, but not uncommonly fever may be entirely absent, the temperature being subnormal and coma present. The outlook is exceedingly grave, death usually ensuing in from five to seven days after the onset.

The only Treatment which holds out any hope in dealing with a limb where the disease is rapidly extending is a high amputation, even through the shoulder or hip-joint. Any delay is dangerous, although, in spite of the greatest promptitude, the infection may have progressed so rapidly that death follows from septicæmia, even after the limb has been removed. Perhaps it may be wise to leave the wound widely open for a day or two so as to permit the free discharge of secretions. In a few cases, where the patient is seen early, it has been possible to save both life and limb by freely incising the affected tissues, and immersing them in a continuous warm antiseptic bath. At the same time the general health must be attended to by giving plenty of fluid nourishment, together with diffusible stimulants, such as ether and ammonia.

(b) Wound Phagedæna and Hospital Gangrene were seen often enough in the pre antiseptic era, but are now practically unknown. They consisted in a rapidly spreading ulceration or gangrene, which attacked operation wounds a few days after their infliction, and as a rule led to rapid death.

(c) Necrosis of Bone is almost always due to the development of organisms, and may be either acute or chronic. In the former, the inflammatory reaction is so severe that the vessels are strangled within the bony alveoli, in the latter, it is largely due to an obliterative endarteritis, which accompanies the various specific processes. (See Chapter XX.)

(d) Cancrum Oris and Noma—Cancrum oris is an infective-gangrenous stomatitis, affecting young children living in squalid surroundings in over-populated districts of large cities. The patients are always in a low state of health, and frequently convalescing from one of the exanthemata, particularly measles. Various special

organisms have been described from time to time as responsible for cancrum oris, but it appears that any of the many forms found in the mouth may be present, and probably the *Streptococcus pyogenes* acting in conjunction with various saprophytic bacilli is the most important. The process starts in an abrasion of the mucous membrane, which, being infected from a diseased or dirty tooth, becomes inflamed and gangrenous. A foul ashy-gray pultaceous slough forms on the inside of one of the cheeks, and from this a most offensive discharge is poured into the mouth and swallowed, the breath in consequence becoming intensely fœtid. The gangrene gradually spreads both superficially and deeply, the cheek becomes swollen, shiny, and tense, and, should the process extend through its whole substance, a black slough appears on its outer aspect. In bad cases, the adjacent bones of the face may be affected and die, and the tongue, palate, and even the fauces, may also be involved.

The general phenomena are those of a severe sapræmia, since not only are the toxic products swallowed, but they are also absorbed by the lymphatics, and may be inhaled, in the latter case giving rise to septic pneumonia. Moreover, the patient runs a considerable risk of developing pyæmia, from implication of the facial or other veins in the necrotic process, whilst infective septicæmia may also supervene. Rigors and high fever may occur early in the case, but death is usually preceded by symptoms of collapse and coma with a subnormal temperature.

The **Treatment** must be prompt and energetic if the child's life is to be saved. The patient should be anæsthetized, and all the pultaceous slough scraped from the interior of the mouth by means of Volkmann's spoon, until healthy bleeding tissue is reached. The denuded surface is then freely rubbed over with pure carbolic or strong nitric acid. If the bones of the face are involved, they must be removed, as also any offending teeth. Afterwards the child should be well fed up, and of course for a time with fluids, the mouth is to be frequently washed out with antiseptic lotions, such as a solution of sanitas (1 in 10), boroglyceride (1 in 20), or permanganate of potash, or with a gargle of chlorate of potash (10 grains to 1 ounce). A mixture containing chlorate of potash, dilute hydrochloric acid, and infusion of cinchona, may be administered for a few days, and then iron and quinine. In the most severe cases the same treatment should be adopted, even if the whole thickness of the cheek has been encroached on, loss of substance must be made good by subsequent plastic work. Necessarily, the cicatrization following this destructive process results in a good deal of permanent impairment to the movements of the jaw.

**Noma** is the name given to a similar process occurring about the genital organs of children, especially the vulva. The **Treatment** is practically the same, except that here it is possible to immerse the patient in an antiseptic bath, thereby diluting the toxic products, and possibly preventing the necessity for having recourse to more serious surgical procedures.

(c) For Carbuncle and Boil, see Chapter XVI

## IV Gangrene from Thermal Causes

1 Frost-bite — This condition is not often seen in this country, but is by no means uncommon in regions where the winter is colder, and is induced more readily if a high wind is blowing, the heat of the body being thereby more quickly dispersed. Children and old people are more likely to be attacked, as their vital powers are less marked than in adults. It originates in one of two ways

(a) *From the direct effect of cold on the tissues*, which become shrunken, hard, and of a dull waxy appearance. No pain is experienced in the freezing process, so that onlookers are more likely to recognise the condition than the individual himself. The extremities of the body, where the circulation is a little sluggish, and exposed parts, such as the nose and ears, are chiefly liable to be attacked. Gradually the part shrivels up, turns black, and is either absorbed or separated by a process of ulceration with or without suppuration. A marked feature of gangrene from frost-bite is the more extensive implication of the superficial tissues on account of their greater exposure

(b) *From the subsequent inflammation* in parts which, though frozen, are not immediately killed. The thawing of these structures is accompanied by severe pain, and the prolonged anæmia so depresses the vitality of the vessel walls that the re-admission of the circulation is likely to be followed by an acute inflammation, which terminates in necrosis from compression of the vessels by the rapidly-formed exudation. If it escapes actual death, the part remains red, congested, and painful for some time, and superficial ulcers may even develop, eventually, however, it recovers

**Treatment** — The frozen parts must be thawed very gradually, and the blood admitted into the tissues slowly, if inflammatory gangrene is to be avoided. They should be gently rubbed with snow or cold water, and warmed by being held in the hands of the manipulator, whilst the patient should be placed in a cool room, the temperature of which is slowly raised. As reaction comes on, a small amount of warm drink may be cautiously given. Excessive pain or congestive œdema may be limited by elevation of the part. If actual gangrene occurs, the dead tissue must be rendered and kept aseptic, and the case carefully watched until a definite line of separation has formed

2 Burns and Scalds — These may be considered as a special variety of wound, not necessarily ending in gangrene, brought about by the action of heat, burns, either by the close proximity to, or direct contact with, flame or heated solid bodies, scalds, by the action of boiling water, superheated steam, or other hot fluids or gases, the difference in the effects being comparable to the distinction between roasting and boiling. Naturally, fluids such as oil, which boil at a higher temperature than water, produce increasingly severe results

Six different degrees of burn were described by Dupuytren, and

his classification may still be retained with advantage. The *first degree* consists merely in a scorch or superficial congestion of the skin, without destruction of tissue, the part may, however, remain red, painful, and prone to ulceration for a time. Should the scorch be often repeated, as by people constantly warming their legs before the fire, the skin becomes chronically pigmented and indurated (*erythema ab igne*). In the *second degree* the cuticle is raised from the cutis, and a bleb or blister results. When this bursts, and the cuticle is removed, the cutis vera, red and painful, is exposed below. In the *third degree* the cuticle is destroyed, as is also part of the cutis vera, but the tips of the interpapillary processes, including the exquisitely sensitive nerve terminals, are laid bare and left intact, consequently this is a most painful form of burn. The deeper structures of the skin—viz, the sweat and sebaceous glands, and the hair follicles—remain untouched, so that, although the surface during the healing process becomes covered with granulations, the integument is very rapidly replaced, since there are so many epithelial elements from which it can grow. The cuticle is able to form not from the edge only, as must occur wherever the whole of the cutaneous envelope is destroyed, but also from innumerable foci scattered over the wound surface. The resulting scar, though often white and visible, undergoes no contraction, it is supple and elastic from containing all the elements of the true skin. In the *fourth degree* the whole thickness of the integument is destroyed, as well as part of the subcutaneous tissues. In the *fifth* the muscles are also encroached upon, whilst in the *sixth* the whole limb is charred and disorganized. In the last three forms healing can only occur by removal of sloughs and the formation of a cicatrix, which by its contraction may lead to deformity.

The Local History of a burn may be described in three stages, corresponding to the three stages through which an ulcer or a lacerated wound passes. (1) The stage of destruction or burning, the various degrees of which have been just alluded to, (2) the stage of inflammation and sloughing, whereby the dead tissue is removed, and the wound converted into a healthy granulating sore, (3) the stage of repair, which follows the course described elsewhere (Chapter IX). There are no special characteristics of these processes which call for particular note, except that they are usually of a septic nature, unless the burn is a small one. The skin is usually dirty (from a surgical standpoint) at the time of the accident, it may be infected from the clothes which are being worn, and immediate attention may be impossible. Moreover, the extent of the lesion and the terrible pain associated with it often render complete sterilization impracticable.

The General or Constitutional Conditions which correspond to these three stages require a little fuller notice.

1. In the early stages *shock* is usually present, and its intensity depends as much on the extent of the burn as on its depth, so that total charring of a limb may cause less depression of the system than

an extensive superficial scorch, especially if the latter involves the abdomen. It frequently passes into a condition of collapse, due in measure to the absorption of toxic products from the burnt tissues.

2 Subsequently a period of *inflammatory fever*, usually of septic origin, follows, and may last four to fourteen days. The viscera become congested, particularly the gastro-intestinal canal, liver, lungs, and brain, and various complications may result therefrom.

One of the most interesting sequelæ, though at the present day it is admittedly uncommon, is **Ulceration of the Duodenum**. Its presence is suggested by pain in the epigastrium after food, perhaps some vomiting, which may be blood-stained, and possibly the passage of a motion containing altered blood. Occasionally the first sign of such mischief is the sudden collapse of the patient, followed by death, with or without peritonitis, owing to perforation or excessive hæmorrhage (Chapter XXXIV). The bleeding generally arises from erosion of the superior pancreatico duodenal artery. The ulcers are of the usual duodenal type, and occur close to the orifice of the bile-duct. They probably result from the elimination by the liver of some irritating substance derived from septic or other changes in the burnt tissues which is capable of inducing thrombosis, or of producing ulceration in the structures in close contiguity to the entrance of the bile-duct. In one case under observation, a post-mortem examination revealed a patch of well-marked ecchymosis in the duodenal mucosa exactly opposite the orifice of the bile duct. Obviously it was the early stage of this condition, and would have gone on to ulceration had the patient lived.

3 When healthy repair is occurring locally, and the parts are kept aseptic, no abnormal constitutional condition should be present, although there may be a certain amount of *asthenia* or *anæmia*. Where, however, the wounds are septic and suppurating freely, this tendency will be much more marked, and the patient may even develop hectic fever and amyloid changes in the viscera, and finally die of exhaustion.

**Causes of Death from Burns**—If an individual is burnt to death, the fatal event is usually occasioned by *asphyxia* from the smoke and noxious fumes of the fire, shock and syncope from fright may perhaps be ~~adjuncts~~ *adjuncts*, especially if the heart is weak or diseased. Within the first few days death results from *shock* or collapse from *toxæmia*, in the second stage, from *sepsis*, internal complications, ulceration of the duodenum, etc., in the third stage, from exhaustion or intercurrent maladies. The prognosis in children is always more unfavourable than in adults.

**Treatment**—In superficial scorches without vesication, all that is needed is to protect the affected parts, *e.g.*, by dusting them over with *boric acid* powder mixed with starch, or by painting them with collodion. Blisters should be washed antiseptically and then punctured, so as to allow the contained serum to escape, and then the area should be dusted with boric acid powder, and covered with aseptic wool. *Carron-oil* (*i.e.*, a mixture of equal parts of linseed-

oil and lime water) is often used, applied on lint, it is, however, not an antiseptic, although by adding a small proportion of eucalyptus oil (1 to 10) this can be corrected. Picric acid may be used when the cutis vera has not been entirely destroyed, the vesicles are punctured, and then a piece of lint, soaked in a solution of picric acid (20 grains to 1 ounce of sterilized water), is applied to the burnt surface, and over this, in turn, a pad of salicylic or sterilized wool is bandaged. Thus a dry dressing is produced, which may be left *in situ* for some days, when it is re-applied. The results are sometimes most satisfactory.

Where the burn includes deeper structures, the clothes must be removed with as little dragging as possible, being cut away if necessary, the damaged tissues are then bathed with some antiseptic, such as sublimate lotion (1 in 2,000), and covered up as rapidly as possible with lint soaked in eucalyptus-oil or weak carbolyzed oil (1 in 40). In some cases, where the skin and surface are exceedingly dirty, it is well to anæsthetize the patient, cut away parts which must obviously slough, and thoroughly purify the wound, which is covered with protective and dressed with cyanide gauze or some such material.

If the patient is in a state of shock, he should be put to bed and covered with warm blankets or rugs whilst perhaps a little warm stimulating fluid is administered, in bad cases an intravenous injection of hot saline solution is advisable, and it may often be repeated with advantage. In the case of children with very extensive burns, it is sometimes useful to put them into a hot bath, to which some eucalyptus-oil, if obtainable, has been added, the clothes are then removed or cut away, and the patient allowed to remain for some time, or until the shock has subsided, in the warm water, which should be replenished, if necessary. The wounds are then dressed, and the little patient removed to bed. It may be desirable to repeat the immersion at every dressing.

When a limb has been hopelessly charred or burnt to the bone, it is useless to retain it, and early amputation through the nearest healthy tissues should be undertaken.

During the stage of inflammation and sloughing the only requisite is to keep the parts as free from sepsis as possible, assisting the natural processes of repair by warm moist applications, and snipping away sloughs as they loosen. Subsequently the wounds are treated on general principles. The granulations often become prominent, and stimulating applications, such as touching them with lunar caustic, may be necessary. In large wounds, healing should be assisted by skin-grafting, according to Thiersch's method, unless some such proceeding is instituted, the wound is likely to become chronic, and healing may be delayed perhaps indefinitely.

## CHAPTER VII

### SPECIFIC INFECTIVE DISEASES

#### Erysipelas

ERYSIPELAS is a contagious infective disease due to the development of the *Streptococcus erysipelatis* (Fehleisen) in the smaller lymphatics of the skin and occasionally of mucous membranes, with a decided tendency to spread and to recovery without loss of tissue, the constitutional symptoms being due to the absorption of toxins developed locally. Occasionally the subcutaneous connective tissue is also involved, constituting the variety known as *cellulo-cutaneous erysipelas*.

There has been considerable discussion as to whether there is any difference between the erysipelas microbe and the ordinary *Streptococcus pyogenes* found in spreading suppuration. The microscopical characters are indistinguishable, and the growth in various reagents is very similar. Inoculation experiments, moreover, certainly seem to indicate that they are closely allied species, and the majority of bacteriologists consider them to be identical, the differing effects depending merely on the methods of inoculation and the virulence of the particular organism. It is well known that strains of the *Streptococcus pyogenes* from different sources vary enormously in virulence, and, further, that a culture which is practically non pathogenic can have its virulence exalted by repeated passage through animals to such a degree that an exceedingly minute dose—perhaps a single coccus—proves fatal.

The Causes of erysipelas may be briefly stated as follows (1) The existence of an abrasion or wound in most cases, and particularly of an unprotected septic wound. Thus, it is not uncommon to find it associated with neglected scalp wounds or with those communicating with the mouth. (2) A weak, depressed state of the constitution, as from alcoholism, vicious living, diabetes, albuminuria, etc. Some people, moreover, seem naturally predisposed to the disease, particularly plethoric and gouty individuals, and one attack

\* It is becoming very doubtful whether erysipelas is to be looked on as a specific infection. Careful bacteriological examination is indicating that other pyogenic organisms than the *Streptococcus* may be responsible for its appearance, and it is possible that hereafter we may have to relegate it to the chapter dealing with non-specific infections.



renders the subject more liable to recurrence after a short period of immunity (iii) Bad hygienic surroundings are a most important additional factor in its production, especially overcrowding in hospitals and bad ventilation. But these are all merely predisposing conditions, the only exciting and absolute cause is (iv) infection with the particular micro organism. In the so-called *idiopathic* form infection occurs through some slight abrasion, or even through sound skin or mucous membrane. When once an entrance has been effected, the cocci develop in the superficial lymph channels, producing a transient local inflammation and a concurrent pyrexia from absorption of toxins.

The **Symptoms** of the disease are usually ushered in by a slight chill, scarcely amounting to a rigor, and by a period of headache and malaise for about twenty-four hours with some degree of pyrexia. These symptoms are followed by the development of a bright, rosy-red rash, spreading either from the margin of the wound, or showing itself in apparently unbroken skin in the so-called *idiopathic* variety. If there is a wound, it usually presents a yellowish, unhealthy-looking surface, with very little evidence of repair. If the erysipelatous virus is unmingled with other organisms, the healing process may continue until the rash appears on, about the fourth or fifth day, when the young cicatrix will break open again, exposing a dry and sluggish surface with a thickened margin, it may occur, however, at an earlier date. The *rash* is generally of a characteristic vivid red colour, disappearing on pressure, and accompanied by a sensation of stiffness or burning, scarcely amounting to pain, except when dense structures, such as the scalp, are involved, and then the pain may be very severe. Swelling is not very marked, except in lax areolar tissues, such as in the scrotum or eyelids, the œdema may then attain considerable proportions. The rash continues to advance more or less rapidly, with a continuous slightly raised margin, and as it spreads to new regions it fades away from those already involved, leaving a slight brownish stain and a fine branny desquamation. In some cases it does not spread evenly, but appears to leap over an interval, and then the intervening lymphatics are found to be thickened. Vesicles and bullæ form superficially, containing serum, which speedily becomes turbid, but suppuration is uncommon, except in lax œdematous tissue, such as the eyelids. Occasionally, from the severity of the inflammation or the low state of vitality of the tissues, the skin may become gangrenous and slough, especially about the umbilicus and genitals of young children. Neighbouring lymphatic glands are always enlarged and painful, and this may even be noted at a period when the rash has not appeared. *Periphlebitis* may also be caused, leading to pyæmic complications. Fever is present as long as the rash persists, and merely shows slight diurnal variations. It is not uncommon for the temperature to rise to 104° F, but anything above that is of grave significance. At first the fever is of a *sthenic* type, the pulse full, and the delirium noisy and active, but later on the pulse becomes quick and weak, accompanied by low, muttering

delirium and great prostration of the vital powers. Delirium is usually a well-marked feature in erysipelas of the scalp, but this is due to the general rather than to any local condition, unless meningitis supervenes. The duration of the attack is most variable, lasting, as a rule, from one to three weeks, but relapses are not uncommon.

The so-called **Idiopathic Erysipelas** mainly affects the head, and occurs in predisposed individuals, often recurring about the same time of the year, pain and delirium are prominent symptoms, and the subcutaneous tissues of the face become so swollen that the features are almost unrecognisable. Large blebs form, and abscesses are not uncommon about the eyelids.

**Cellulo-cutaneous Erysipelas** is due to an infection of the skin and subcutaneous tissues with the specific virus, and results in suppuration and sloughing both of the skin and subjacent cellular tissue. The signs are those of a diffuse spreading inflammation, *e.g.*, heat, pain, redness, and swelling of a brawny type at first, but which softens after a while and becomes boggy, the skin giving way, and allowing exit to the pus and sloughs. The general symptoms are correspondingly severe, and pyæmia may supervene. As distinguishing features from ordinary erysipelas, it is stated that the margin of the redness is less defined, and that the lymphatic glands are less enlarged, the whole nature of this affection is still more or less *sub judice*.

**Erysipelas of the Fauces** causes a diffuse inflammation of the mucous membrane of the fauces, often spreading to the glottis and larynx, and arising either by extension from without, or in association with some external manifestation of the disease elsewhere. The fauces and soft palate become of a dusky scarlet colour, and are much swollen. The voice is either husky or absolutely disappears, whilst severe spasmodic dyspnoea may arise from the œdema extending to the glottis. The parts are very prone to ulcerate or slough, and the glands at the angle of the jaw are enlarged. Fever is usually, though not invariably, present, and great depression of the vital powers.

**Erysipelas of the Scrotum**, or, as it is sometimes termed, acute inflammatory œdema, is characterized by the part becoming greatly distended by serum, but without any marked redness. Suppuration and sloughing are not unlikely to follow. It thus somewhat simulates the appearance produced by extravasation of urine, but is distinguished from it by the facts that micturition is usually not interfered with, and that the swelling is not limited in the same way as in the latter affection.

**Diagnosis**—There is not much difficulty in recognising a case of erysipelas if the distinguishing features of the rash are remembered, *viz.*, its method of extension by a broad, sharply-defined, slightly raised and infiltrated red margin. A *septic wound* with pent-up discharge closely simulates erysipelas, but the redness has not such an accurately defined margin and does not spread beyond the immediate neighbourhood of the wound, cutaneous vesicles are not

usual in ordinary sepsis, though common in erysipelas, whilst lymphatic enlargement is not constant. A patch of *cellulitis* will also be distinguished by the same features. Diffuse *erythema nodosum* is recognised by the slight degree of the febrile disturbance, and the presence of outlying patches of redness, which, moreover, are not so clearly limited. There is always considerable pain in this affection, which often involves both legs, and usually occurs in young women of a rheumatic temperament. The so-called *erythema solare* follows exposure to the sun's rays, especially when reflected from water, of parts of the body which are, as a rule, protected, though usually of slight importance, it may sometimes give rise to so much pain, œdema, and constitutional disturbance as to simulate erysipelas. It is readily distinguished by the facts that it is limited to the parts exposed and has no tendency to spread. In acute *eczema rubrum* the presence of a honey like exudation is quite characteristic.

**Pathological Anatomy** —If a person dies of erysipelas, one merely finds the general signs common to all septic cases detailed elsewhere (p 78). The rash will have faded, but on microscopic section of the skin colonies of cocci arranged in chains will be found invading the lymphatics just beyond the spreading margin, whilst in the parts which the inflammation has recently attacked there will be a considerable excess of leucocytes, presumably connected with the destruction and removal of the cocci. The lymph glands will also be found enlarged and congested.

**Prognosis** —Erysipelas is not peculiarly dangerous in itself (Osler gives the death-rate as 7 per cent in hospital patients), but may become so from the complications which attend it. The most important of these are inflammatory conditions of the brain, lungs, and other viscera, especially of the kidneys. Pyæmia and general septic intoxication are also observed. Erysipelas is usually attended with danger to life in old people, drunkards, and infants, whose vital powers become rapidly exhausted. As a local complication, erysipelas is not always unfavourable, since chronic and sluggish wounds will sometimes manifest marvellous reparative power after an attack. Chronic lupoid and syphilitic ulcers may rapidly cicatrize, and even malignant sores, especially sarcomata, have been known to be cured.

**Treatment** —Close attention to the rules of antiseptic surgery should banish erysipelas entirely from ordinary surgical work, but if the surgeon has to treat a case, or if the disease is prevalent, it is wise to be cautious and put off all operations that can safely be postponed. Single cases must be isolated, and kept out of surgical wards. If, unfortunately, a case cannot be completely isolated, the bed should be placed as far away from others as possible, and especially from those with open wounds which from their position (*e.g.*, the mouth) cannot be properly protected from sepsis. It is usual to surround the bed with sheets kept moist with carbolic lotion, and the floor around should be sprinkled with the same. Special nurses and dressers must be told off to attend to the case.

**Local Treatment** —When one considers the bacterial origin of the affection, it is evident that, except in the mildest cases, the old-fashioned plan of merely protecting the part from the air, as by painting it with collodion, or covering it with a thick layer of starch or flour, mixed perhaps with boric acid, was very inefficient, whilst it is equally obvious that the local application of cold is absolutely harmful, as tending still further to depress the vitality of the part. Where tension and pain are severe, fomentations containing opium or belladonna (e.g., 1 ounce of laudanum to 1 pint of lotio plumbi) may be applied, or the parts should be scarified and antiseptic compresses applied, e.g., gauze soaked in carbolic acid (1 in 40) or in sublimate solution (1 in 1,000). Perhaps the best local applications are ichthyol or thiol, the latter being an artificial sulphur compound much resembling ichthyol, but without the objectionable smell. A 20 to 40 per cent aqueous solution is painted over the affected area, possibly after scarification, as well as over the neighbouring healthy skin, several times a day until the fever disappears, such treatment is stated to be usually successful in checking the disease in two or three days, whilst the stickiness of the preparation hinders the diffusion of the virus.

Pressure may be of some value in limiting the spread of the mischief, probably by compressing the lymphatics. A wide band of adhesive plaster wound around a limb beyond the margin of the rash is often effectual, and it may be possible in this way to check its advance from the scalp to the face or neck.

Anything that tends to produce a local accumulation of leucocytes in the skin beyond the spreading edge should be beneficial in checking its advance, and therefore good may be derived by painting around the rash with strong solutions of nitrate of silver or with lin. iod., granting that it is done sufficiently far off to be on healthy skin. The most efficient plan based on this idea is Kraske's, in which the skin is scarified all round at a distance of an inch or two from the spreading margin, the knife going just deeply enough to draw blood, antiseptic compresses are then applied.

*Antistreptococcic serum* should be employed as early as possible, and probably acts by destroying the bacteria by a process of bacteriolysis. Ten or fifteen c.c. of this serum are given subcutaneously as a dose, and repeated once or twice a day. In favourable cases the pain rapidly diminishes, the rash ceases to spread, the temperature falls, and in twenty-four to forty-eight hours the disease may be at an end, but this result is not always obtained, possibly owing to some defect in the preparation of the serum, or to the fact that the animal from which the serum was derived was not immunized to a streptococcus of the same nature as that present in the erysipelatous lesion. To remedy this, a polyvalent serum has been introduced, which is prepared by injecting the animal with cultures of streptococci from many sources.

**Constitutional Treatment** must be of a tonic and supporting character. Good food, easy of assimilation, stimulants and quinine,

should be freely administered, whilst the tincture of the perchloride of iron in  $\frac{1}{2}$ -drachm doses, repeated three or four times a day, is still looked on by many as a specific

In *cellulo-cutaneous erysipelas* early and free incisions must be made to relieve tension, and, if possible, anticipate suppuration. The tissues, when incised, look gelatinous from the œdema present, and much fluid of a sero-purulent type will escape. If this is not undertaken, considerable portions of skin and subcutaneous tissue may slough. Antiseptic poultices should be employed after the incisions have been made, until granulations have developed.

In *erysipelas of the fauces* the parts must be painted or freely sprayed over several times a day with antiseptic lotions, such as liquor argenti nitratis (10 grains to 1 ounce), liq hydrarg perchlor (1 in 2,000), or liq sodæ chlorinatæ (1 part to 15 parts of water), whilst tracheotomy may be needed if the glottis is involved. Diffusible stimulants and plenty of nourishment are urgently necessary to combat the depressing effects of this disease.

### Tetanus

Tetanus is a local infective disease, due to the *Bacillus tetani*, and the characteristic symptoms are of a toxæmic nature.

**Predisposing Causes**—1 *Climatic Influences*—It is most commonly seen in the tropics, where it may be almost epidemic, probably owing to the heat favouring the development and virulence of the organisms in the soil, hot seasons assist its activity, and particularly when hot days are followed by cold nights.

2 *Personal Proclivity*—It was formerly considered that negroes and stable attendants were specially liable to this disease, owing to some peculiar idiosyncrasy, but such an idea cannot now be maintained. The causative organism is a facultative saprophyte—i.e., is capable of continuing its development apart from the body—and is almost constantly found in garden soil, dust, or dirt of any kind. Those, therefore, who are likely to be much brought in contact with the ground, e.g., negroes and agricultural labourers, owe their liability to the disease to their more constant exposure to infection. Horses are peculiarly susceptible to tetanus, and the bacilli are usually present in their fæces, hence stablemen and others brought into contact with horses are attacked with comparative frequency.

3 *Bad Hygiene* is a most important predisposing condition. Every hygienic error favours its appearance, but especially the overcrowding of sick and wounded people into a limited space, and especially if full antiseptics is impossible.

**Exciting Causes**—1 The existence of a *wound*. It may follow a lesion which causes no breach of surface, such as a blow with the fist, or a bruise, but in the great majority of cases there is a definite solution of continuity of the skin. Any region of the body may be thus affected, and it is rare for tetanus to occur in any but septic wounds, where asepsis has been fully maintained the development

of tetanus is almost unknown. Punctured or lacerated wounds of the sole of the foot, perhaps due to a dirty or rusty nail, are favourable conditions for the development of tetanus, whilst gunshot wounds due to blank cartridges are often followed by it. The explanation in the later case seems to be that the injury is largely due to the wad, which is made of coarse horse-hair felt, and is therefore likely to contain spores of the bacillus.

2 Infection with the *B. tetani*. The first clue to the infective nature of this disease was obtained from the observation that, if portions of soil or garden mould were placed under the skin of animals, they died in a short time with tetanic symptoms, and in the pus and walls of the resulting abscess characteristic bacilli were observed. Experimenting in the same way, it has been found that the bacilli or their spores are very widely disseminated, and, indeed, are present in almost every sample of garden or field soil, they have been found in the grime on a working man's hand and on dirty surgical instruments. Great difficulty was experienced in isolating

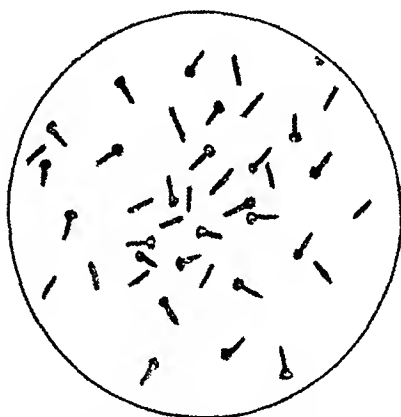


FIG. 16 — BACILLI OF TETANUS FROM ARTIFICIAL CULTURE, SHOWING THE SPORES LOCATED AT THE ENDS OF THE RODS ('DRUMSTICK' BACILLI)

and getting pure cultures of the bacillus, but at last Nicolaier and Kitasato succeeded, by heating the pus from an infected wound to a temperature of  $80^{\circ}\text{C}$  for an hour, thereby destroying all the pyogenic and septic microbes. It occurs in the form of delicate straight rods, which when developing in the body sometimes grow into long threads. It is a strict anaerobe, ceasing to grow if the smallest trace of oxygen is present, and is usually cultivated in an atmosphere of hydrogen or nitrogen. The tetanus bacillus differs from most organisms which resemble it in that it does not produce gas on cultivation. It forms characteristic spores which are nearly spherical in shape and situated at the extreme end of the bacillus, giving it the appearance of a drumstick (Fig. 16). It stains by Gram's method and possesses numerous flagella. The bacilli themselves are not powerful parasites, and when separated completely from their toxins often fail to cause infection when injected into

susceptible animals, should, however, a minute trace of toxin be present, it so depresses the vitality of the surrounding tissues that the bacilli continue to grow and produce more toxin. Hence we find that tetanus rarely occurs in man as the result of clean wounds which heal rapidly, but is much more likely to occur as the result of injuries accompanied by bruising and laceration, or in septic wounds where the vitality of the tissues is depressed by the toxins of the septic organisms, in the latter case, too, the septic bacteria absorb any oxygen present, and give rise to the necessary condition of anaerobiosis.

In pathology tetanus forms the best example of a local infection with general toxæmia. The bacilli remain localized in the neighbourhood of the wound, and do not enter the blood or reach distant parts of the body to this rule only three or four exceptions have been recorded. In this region they produce their toxins, which act on the cells of the central nervous system in a manner very similar to strychnine. There is, however, a very unusual feature in the mode of passage of the toxin from the local lesion to the brain and cord, in that it appears to travel in the nerves themselves, and not in the blood, as in the other infections. One or two of the proofs that have been advanced in support of this theory may be quoted. Tetanus may be caused by the injection of a very small dose of toxin directly into a nerve, whereas the animal may resist the injection of four or five times this amount into a muscle, and if the nerve is cut between the site of inoculation and the central nervous system, the spasms may be delayed or even prevented altogether. This may explain the beneficial effects which sometimes followed the now abandoned operation of nerve stretching or section in tetanus. Further, the toxin can be demonstrated in the nerves themselves, since they give rise to tetanus when introduced into a susceptible animal, and it is even possible to form some idea as to the amount contained in different nerves. Thus the toxin has a special affinity for the motor nerves, and large amounts have been found in the nerve to the masseter muscle, an interesting fact in view of the frequent occurrence of trismus.

The post-mortem anatomical changes are not characteristic. The muscles are often pale, or show evidences of rupture or extravasation of blood. The peripheral nerves extending from the wound may be red and congested for some distance. This may not be due to the action of the toxin (which appears to produce no demonstrable lesions of the nerves themselves), but to septic inflammation. The nerve-centres frequently present areas of softening and perivascular cellular exudation, with some hyperæmia. Minute changes may also be demonstrated in the nerve-cells.

**Clinical History** — **Acute Tetanus** usually manifests itself in this country two or three weeks after infection (but sometimes abroad as early as a few hours or days) by a difficulty in opening the mouth, associated with a cramp-like pain in the muscles of mastication and of the neck. This soon becomes so marked that it may

be difficult even to insert a paper-knife between the teeth (*trismus*, or lock-jaw), causing great difficulty in the administration of food, to it is added a fixed and rigid condition of the muscles of the back of the neck and of the face, the latter producing a curious grin-like appearance (*risus sardonicus*), whilst *dysphagia* is sometimes caused by spasm of the pharyngeal muscles. A considerable degree of fever is often manifested, but in some cases an apyrexial course is maintained until nearly the end. The spasms soon extend to the trunk and extremities, accompanied by cramp-like pains, and when fully established they may be excessively painful and violent, and the remissions between them but partial. Fortunately the disease usually involves the respiratory muscles late in the attack. The spasms can be excited by any form of stimulus, such as the slamming of a door, a draught of cold air, or some voluntary movement, and are always of a tonic (i.e., continuous) character. The body is contorted in various directions, and respiration may be much impeded by the fixation of the thorax. Occasionally the body is arched backwards (*opisthotonos*) by the contraction of the muscles of the back, the recti abdominis being firm and tense—'as hard as boards', sometimes it is doubled forwards (*emprosthotonos*), and in rare cases laterally (*pleurosthotonos*). The muscles may contract so violently as to be ruptured, whilst teeth have been broken and the tongue has been almost bitten off. The intellectual faculties usually remain clear to the end, which is generally due to exhaustion from a repetition of the convulsions, or more rarely to asphyxia induced by a prolonged fixation of the respiratory muscles. Before death the temperature sometimes runs up to  $108^{\circ}$ , or even, in one case, to  $112^{\circ}$  F, and it often continues to rise for a degree or two after death, such hyperpyrexia is mainly due to the continuous muscular contractions. The surface of the body is bathed in sweat, and the urine occasionally albuminous. Death may occur in twenty-four hours from the onset of the disease, or not for four or five days.

**Chronic Tetanus** usually begins later after infection, is less severe in its symptoms, and more likely to be recovered from. The course is usually afebrile, and the spasmodic contractions may be limited to the wounded part of the body whence the infection has arisen, or may be general. Sometimes the patient lies in bed with his jaw partially fixed, and the muscles of his neck, back, and abdomen rigidly contracted, but with none of the characteristic convulsions.

A special variety known as *cephalo-tetanus*, or *T paralyticus* (German, *kopf-tetanus*), follows injuries within the area of distribution of the cranial nerves, and especially those about the supra-orbital margin, it is characterized by the association of trismus with facial paralysis, although spasms, both tonic and clonic, occur in other parts of the body. Spasm of the muscles of deglutition and attacks of maniacal frenzy are sometimes present, and hence the name *T hydrophobicus* which has been applied to it. The paralysis is supposed to be due to an ascending neuritis of the facial nerve, which becomes compressed in the aqueductus Fallopii. The



condition is uncommon, and the prognosis not quite so grave as in the acute cases

The **Diagnosis** of tetanus is rarely difficult. In the early stages it must be distinguished from simple *trismus* arising from dental irritation, or from inflammatory ankylosis of the temporo-maxillary joint. This may be readily accomplished by noting that rigidity of the neck muscles is also present in tetanus. In the later stages *strychnine-poisoning* leads to a very similar group of symptoms, but is recognised from it by the contractions being more sudden and violent, the relaxation of the muscles between the spasms complete so that the mouth can readily be opened, whilst the hands are involved in the contractions, a rare sign in tetanus, and the muscles of mastication often escape.

No difficulty should be experienced in distinguishing tetanus from *hydrophobia*, owing to the very different nature of the convulsions in the latter case—i.e., clonic and not tonic, moreover, they affect the muscles of respiration and deglutition, whilst the history of the case, the early hallucinations, and the absence of tonic muscular contractions, are also characteristic features.

Laboratory methods are usually unnecessary for the diagnosis of the disease when developed, but in case of doubt the best method is to collect some of the discharge from the deeper portions of the wound, dilute it with broth, and divide it into two parts. One of these is to be injected into a mouse or guinea-pig, whilst the other portion is mixed with 1 c.c. of tetanus antitoxin and then injected. If the former animal develops tetanic symptoms, whilst the latter escapes, the diagnosis is assured.

The **Prognosis** is unfavourable in any case, but the so-called idiopathic variety is less fatal than the traumatic. The longer the case lasts, and the lower the temperature, the more likely is the patient to recover, whilst an acute onset, hyperpyrexia, sleeplessness, delirium, and strabismus are bad signs. The length of the incubation period is also a most important factor, since it has been shown that if it is under ten days, only 4 per cent. recover, whilst if it lasts for eleven to fifteen days, 27 per cent. of cures may be expected, and if the outbreak is delayed for fifteen to twenty days, 45 per cent. of the patients live.

**Treatment**—Careful antiseptics applied to wounds is the surest means of *preventing* its occurrence, and the worse the sanitary conditions in which patients are found, and the more ragged the wound, the stricter should be the measures employed, in places where tetanus is known to be rife, it would be a wise precaution to administer antitetanic serum as an immunizing agent in cases of wounds or abrasions that might possibly be infected, especially if suspicious bacilli are found on microscopic examination of a scraping from the deeper parts of the wound.

After the disease has appeared, the originating sore, if accessible, should be freely excised and the wound cauterized, or the limb may be amputated, but even then the tetanic convulsions may remain

for a time, or even prove fatal, from the amount of toxin already in the system

In addition to these local measures, the specific antitetanic serum (prepared from the blood serum of an immunized animal) should be injected. The serum is purely antitoxic and has no effect upon the development of the bacilli, for the destruction of which local phagocytosis or other immunizing action has to be relied on. Any toxin circulating in the blood is readily destroyed or neutralized, but inasmuch as the toxin rapidly unites with the protoplasm of the nerve-centres, and then cannot be influenced by the antitoxin, the results of its use are often disappointing, since the amount of toxin already capable of causing spasmodic phenomena may be considerable, and has to work off its activity before a cure can be effected. The treatment should always commence with a large dose, and smaller amounts should then be administered once or twice a day, varying with the severity of the symptoms, 20 to 30 c c may be given as the initial injection, followed by doses of 10 to 15 c c twice a day. This is introduced into the subcutaneous tissues of the abdomen and back, or in somewhat smaller doses into the veins, and causes but little inconvenience. During the last few years intracerebral injections have been frequently utilized, in the hope that thereby the toxin absorbed in the nerve-centres may be acted upon, and that unaffected nerve centres (especially the organic centres in the medulla) may be protected. The injection is made through the dura mater into the posterior portion of the second frontal convolution on each side, 2.5 c c of the dried serum dissolved in 5 c c of sterilized water are injected very slowly, and this may be repeated several times, if an interval of a few days is allowed to elapse between each injection. The point selected is placed midway between the external angular process of the frontal bone and the centre point of the line between the root of the nose and the external occipital protuberance. A small trephine may be applied here, or simply a hole drilled through the skull sufficient to allow of the introduction of a syringe, which is pushed about two inches deep into the brain. Of course, the strictest asepsis is essential. Probably it will be found wise to restrict this plan to the treatment of the worst cases, and it must be augmented by subcutaneous injections and other subsidiary measures. Another plan of treatment, suggested by Baccelli, consists in the hypodermic injection of carbolic acid, 10 or 15 minims of a 2 per cent solution are injected two or three times a day, and although its action cannot be explained, yet it seems efficacious if statistics can be relied on. The percentage mortality of the cases treated in this way hitherto reported is certainly less than that accompanying the serum treatment.

The patient should be kept absolutely quiet in a darkened room, and free from all sources of irritation. Food should be nutritious, fluid, and unstimulating, it has been suggested to feed the patient twice a day by a stomach-pump under chloroform. When the trismus is very marked, he may be fed by a soft rubber catheter passed into the pharynx through the nose, unless there is a sufficient

gap between the teeth to admit of its entrance. Opium, chloral hydrate, bromide of potash, physostigma, and curare, have been vaunted as beneficial drugs, but probably cases which have recovered after their exhibition would have done so without. Chloroform should be administered to control the spasms.

### Hydrophobia

Hydrophobia is an acute general infective disease, transmitted from animals to men especially from rabid dogs, wolves, etc. It consists in an affection of the central nervous system, and one of its most marked features is the long and variable incubation period. It never originates idropathically either in animals or man and although the actual virus has not yet been isolated, there can be no doubt that it is a micro organism. Infection usually follows a bite but if the teeth pass first through a garment, the virus may be wiped off, and the individual may escape. It has also been proved that if an infected animal merely licks an abraded surface the disease may be transmitted even when the animal has not at the time shown any of the more typical signs of rabies.

In the Dog, rabies manifests itself three to five weeks after infection, but the period varies considerably, the original wound usually heals perfectly, or there may be some inflammatory thickening about it. Two chief varieties have been described—the raging or maniacal and the quiet or dumb. *Rabies with frenzy* commences with a stage of depression, which is manifested by snappishness and irritability especially towards other animals, by restlessness, and by the dog moping in dark corners, with a depraved appetite, eating any kind of rubbish or dirt, and even its own excreta. This period lasts for two or three days, and is perhaps the most dangerous, since there is nothing very suggestive about the symptoms. It is followed by a period of frenzy and maniacal fury, and this in turn is succeeded by a stage of paralysis, going on to death. During the whole attack the mouth is filled with ropy saliva, which the animal vainly tries to scratch away, the bark loses its ring and becomes hoarse, and as the disease progresses the lower jaw becomes paralyzed finally, after partial or general convulsions, the animal dies five or six days from the onset. In the *melancholic or dumb form* the animal succumbs more rapidly, passing through the same stages as the above, with the exception of the maniacal period. The disease lasts then but two or three days.

In Man the incubation period is most variable lasting from days to months or years, but as a rule it does not exceed six weeks. During this interval the wound heals although the scar may remain tender and neuralgic. The disease is ushered in by a vague sense of terror, with illusions of the senses and disturbance of the mind, lasting for about twenty four hours. Restlessness sleeplessness, loss of appetite, and a repugnance to fluids follow with perhaps some slight febrile disturbance. The more characteristic symptoms are inaugurated by a convulsive stiffness of the tongue, neck and especially of the muscles of deglutition and respiration, which becomes more marked if any attempt is made to swallow. These convulsions are clonic in character and thus differ from those of tetanus, they become more and more generalized being brought on after a time by almost any afferent impulse however slight—such as a blast of cold air, a flash of light, a sudden noise especially such as is caused by the movements of fluids. Swallowing is quite impracticable. The mouth is usually filled with ropy mucus, which is very difficult to remove. The respirations become catchy and a hiccupping noise may be produced by the spasm of the diaphragm, which is sometimes thought to resemble the barking of a dog. Finally, the convulsions may entirely cease, and the patient dies retaining his consciousness to the end the fatal issue being due to the destructive changes taking place in the medulla or to exhaustion. It may, however, occur earlier, from spasm of the glottis. The disease lasts about a week but may be more rapid, killing even in two days.

The Post-mortem Changes are mainly negative. Evidences of acute inflammation of the lower part of the medulla, including the centres for the 9th 10th,

and 11th nerves, are observed on microscopic examination, the vessels being thrombosed and the connective tissue infiltrated with leucocytes. The nerve fibres and ganglion cells may also be found degenerated. The salivary glands are always somewhat enlarged.

**Preventive Measures** should be adopted *immediately* in all cases of bites from dogs which are either rabid or may possibly become so. The circulation in the limb should be arrested by a string or bandage, bleeding encouraged, and some powerful caustic *e.g.*, pure carbolic acid, applied as soon as possible. A free excision of the part is, however, preferable.

**Pasteur's Preventive Treatment**—A few years back M. Pasteur discovered the fact that the injection of an attenuated virus in increasing doses, and in gradually increasing strength, protects an animal or individual from the disease, and *mirabile dictu!* will even catch up the poison already inoculated, and save the patient from its subsequent development, if too long a start has not been given. The method employed is as follows. A virus of constant and maximum intensity is first obtained by passing the poison from a dog through a series of rabbits until the disease appears with regularity on the seventh day, all parts of the cord being then equally virulent. The material inoculated is obtained by mashing up a portion of the spinal cord or medulla of the diseased dog in sterilized broth, and injecting it with a hypodermic syringe beneath the arachnoid after trephining. All that is now needed is to take a series of these virulent cords and dry them by hanging in a glass bell jar with some caustic potash at the bottom for variable periods, the virus being thus weakened in its intensity, until at the end of fourteen days it is completely destroyed. Individuals are inoculated with portions of such cords, pounded up in sterilized broth, beginning with the weakest, and gradually increasing the strength of the injection, until a preparation of a cord which has merely hung one day is used. This method of treatment was introduced in 1885, and the results hitherto obtained have been such as to indicate that we have here a most potent preventive agent against hydrophobia, granted that the disease has not been allowed too long a start. When the disease has attacked an individual, only palliative treatment can be adopted. Every source of irritation and disturbance must be removed, and the patient kept absolutely quiet. With a view to diminish the spasms, chloral may be administered internally, or chloroform inhaled, or cocaine sprayed on the fauces. All the nourishment that the patient can possibly take should be administered, with the addition of stimulants.

## Anthrax

This disease results from infection with the *Bacillus anthracis* which produces in sheep and cattle the so called 'splenic fever'. In man if the microbe is inoculated through the skin, it produces a form of carbuncle known as a 'malignant pustule,' although occasionally a more diffuse condition termed 'anthrax oedema' arises from local infection, whilst if the virus is absorbed by the lungs or intestinal canal, it originates a general inflammatory disorder, known as 'woolsorters disease,' or anthracæmia.

The *B. anthracis* (Fig. 17) is one of the largest of the pathogenic organisms, measuring 5 to 20  $\mu$  in length, and 1 to 1.5  $\mu$  in breadth. It is found in the blood of diseased animals in the form of rods or threads composed of a variable number of individual elements (from two to ten). It is aerobic, immobile, grows best at about blood-heat and liquefies gelatine. Well marked spores are formed within the bacillus when cultivated artificially and in the presence of oxygen, but spore formation has not been observed in the living tissues. The bacilli are readily killed by boiling for a few seconds whilst the decomposition of the carcass in which they are present causes their death in about a week. The spores, however, are very resistant for whilst a 1 per cent solution of carbolic acid kills the bacilli in two minutes the spores remain alive after a week's immersion. Moreover, alcohol and even a 5 per cent solution of carbolic acid have no effect on them. If a mouse is inoculated, say, at the root of the tail with a needle the point of which has been dipped in the blood of an animal which died of splenic

fever, it succumbs in less than twenty-four hours, and bacilli are found in nearly every organ of the body

Some animals are immune against the attacks of anthrax, especially the dog and rat, and one of Pasteur's most useful discoveries was that of artificially providing immunity for cattle and sheep by inoculating them with an attenuated virus, obtained by exposing a cultivation for some time to a high temperature

**Symptoms**—Infection with this organism usually occurs amongst graziers who tend the living animal or butchers who deal with the carcass—it is also met with amongst workers in hides or wool

**Malignant Pustule** commences as an angry red pimple at the site of inoculation, which rapidly spreads, with much infiltration of the base, whilst the centre becomes covered with vesicles, the serum within which contains the typical bacilli. This stage is associated with no pain, but only with great itching and irritation. As the pustule extends, the central part becomes gray and finally black, constituting an eschar or slough, whilst around it upon an area of deep brawny congestion and œdema is a narrow ring of vesicles. The process gradually becomes more marked locally, whilst the lymphatic glands and vessels are also

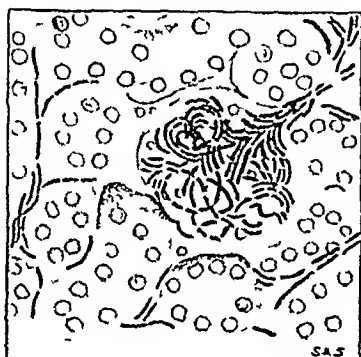


FIG 17—*BACILLUS ANTHRACIS*, FROM SPLENIC PULP OF INFECTED ANIMAL  $\times 1,200$  (CROOKSHANK'S 'TEXTBOOK OF BACTERIOLOGY')

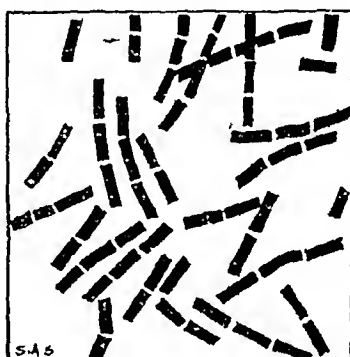


FIG 18—*BACILLUS ANTHRACIS* IN THE SUBSTANCE OF THE KIDNEY, TO SHOW HOW THE TISSUES BECOME INFILTRATED BY IT  $\times 600$  (CROOKSHANK'S 'TEXTBOOK OF BACTERIOLOGY')

enlarged and involved in the disease. Generally, there is a certain amount of fever and malaise, which does not become pronounced until about the fourth or fifth day. The temperature then rises to  $102^{\circ}$  or  $103^{\circ}$  F, the pulse becomes rapid and irregular, and gastric irritability, vomiting, and flatulence, more marked. Should the disease progress unchecked, the respirations become shallow and embarrassed, whilst signs of grave constitutional mischief, such as delirium or coma, manifest themselves and the unfortunate individual rapidly succumbs, generally in less than a week from the onset but sometimes in thirty to forty hours. More commonly the case runs a more favourable course, limiting itself to the local manifestations which gradually clear up the slough separating and the œdema disappearing. Of course, should there be more than one focus of mischief, the prognosis is much worse.

**Anthrax œdema** runs a rapidly fatal course—it is usually seen about the face and eyelids, the skin becoming red and brawny as in erysipelas, and after a time covered with vesicles, whilst finally gangrenous patches appear. The lymphatic trunks and glands are also involved.

**Woolsorters Disease** (or anthracæmia) is the term applied to the general condition resulting from the development of these bacilli in the body without any external lesion. The virus gains access to the system either by swallowing or inhaling the dried spores. If they enter the respiratory tract, the patient

complains of fever and malaise for a few days, followed by the development of a sero-fibrinous pleuro pneumonia, the exudation containing large numbers of bacilli. This runs a rapid course, with high fever, great dyspnoea, impairment of the circulation, and finally collapse in a great majority of the cases. If the bacilli enter the stomach, they are usually destroyed by the acid chyme, but should any of them or their spores reach the intestine, the alkaline contents form a suitable breeding ground, and the walls of the gut are soon attacked and the disease becomes general. Colic, cramps, vomiting, and blood stained diarrhoea are the most marked features in such a case. The intestinal type appears to be not quite so virulent and fatal as the pulmonary, but is decidedly worse than the cutaneous.

**Treatment**—In the cutaneous affection, excision of the necrotic patch and of all the infiltrated tissues around, and the application of the actual cautery or of pure carbolic acid, are usually recommended, though some who have had experience of the affection think such treatment of little value. Large doses of quinine may be given, but for the general disease merely symptomatic treatment can be adopted. De emeti<sup>ca</sup> has been much recommended, both as a local application after internally in woolsorters' disease.

### Gonorrhœa.

Gonorrhœa is an infective process due to the action of a specific micro-organism, the *Gonococcus* or *Diplococcus gonorrhœæ* (Plate I, Fig 6), and characterized (in its commonest form) by a discharge of pus from the urethra. The organism is a diplococcus, and each coccus of the pair is usually kidney- or bean-shaped, and the two lie with their concave borders facing one another. Single cocci and tetrads sometimes occur. It is not easily cultivated, and hæmoglobin is necessary for its growth, the simplest method of preparing a suitable culture medium is to spread some sterile blood on the surface of ordinary agar. The colonies are small and translucent, appearing like droplets of dew. Such cultures set up gonorrhœa when injected into the human urethra, thus proving the causal relation of the organism to the disease, as all of Koch's postulates are fulfilled. The lower animals are all immune. The gonococcus does not stain by Gram's method, this fact is of great importance in diagnosis, since most of the diplococci with which it might be confounded retain the stain. It occurs in large quantities in the pus from a gonorrhœal lesion, and in most cases it is found within the polynuclear leucocytes. This is very characteristic, as also the fact that whilst most of the cells are usually quite free from organisms, yet those that are invaded by cocci contain them in abundance (see Plate I, Fig 6, in which the outlines of the cells are not visible, but in which the diplococci can be seen clustered round the polymorphous nuclei). The pus also contains desquamated epithelial cells, in or on which many cocci may often be seen.

The bacteriological diagnosis of gonorrhœa does not usually involve cultural methods, but can be made by an examination of stained pus films. The best way is to stain by Gram's method, and to counterstain by dilute carbol-fuchsin. In this way the gonococci will be coloured red, whilst most of the other cocci with which they could be confounded are deep violet. The intracellular distribution

of the cocci and the freedom of most of the pus-cells, whilst others are packed full of organisms, are points of great diagnostic value. Some times, however, most of the gonococci are extracellular.

In the male the primary lesion is in the anterior portion of the urethra, the cells of the epithelium of which are invaded by the cocci, and an acute catarrhal inflammation follows, which quickly runs on to suppuration. From this region the inflammation often spreads backward in the continuity of the mucous membrane, deeper portions of the urethra becoming affected. This tendency to local extension is very characteristic of gonorrhœa.

These local lesions usually constitute the whole of the disease, but in some cases the gonococci enter the blood-stream and affect distant organs. The joints are most frequently affected, but occasionally the gonococci attack the cardiac valves and give rise to ulcerative endocarditis (with or without pyæmic abscesses), which leads to a fatal termination. A general pyæmia or septicæmia may also arise in the course of an attack of gonorrhœa from the entrance of other pyogenic cocci (existing as a secondary infection) from the lesion in the urethral mucosa.

**The Symptoms of Acute Gonorrhœa** usually commence within a few days of the infection, varying from two to eight. Most commonly the discharge appears about the third or fourth day, being preceded by itching of the meatus and a scalding pain on passing urine. The lips of the meatus are congested and swollen, and the discharge, which is at first thin and mucoid, soon becomes thick, abundant, and yellow in colour. This stage lasts for a variable time, and is sometimes associated with a good deal of dragging pain in the back and loins, together with some constitutional disturbance and fever. The bowels are usually constipated, and the appetite impaired. Occasionally the swelling and congestion of the mucous membrane are so great as to lead to retention of urine or hæmorrhage from the urethra. The first attack is always more serious than subsequent ones, although it is more amenable to proper treatment. Gouty and rheumatic people are especially difficult to treat, and often suffer from relapses after the discharge has apparently ceased, and it is said that fair people suffer more than those who are dark.

If suitable treatment is adopted, the discharge entirely ceases at the end of two or three weeks, but if neglected, or sometimes in spite of treatment, the inflammation spreads backwards, giving rise to what is sometimes termed a **Posterior Urethritis**, since it involves that portion of the canal which lies behind the deep constrictor. It usually becomes evident about the end of the second week, and is characterized by frequent and painful micturition, a sense of pain and heaviness in the perineum, possibly a little blood in the urine, and a general feeling of depression. This extension backwards is always serious, since it is likely to be followed by complications involving the prostate, testis, or seminal vesicles, whilst it is an extremely common cause of **Chronic Gonorrhœa** or **Gleet**. A more or less abundant discharge continues for some time without any other

troublesome symptom than occasional scalding on passing urine. The discharge is often thin and muco-purulent, but sometimes, if due to chronic prostatitis, it may be so clear and transparent that it resembles uncooked white of egg. Gleet is sometimes due to an ulcerated or granular condition of the mucous membrane, the discharge then being yellow, whilst in others it arises from chronic prostatitis, a condition not uncommonly associated with chronic enlargement of the vesiculæ seminales. The latter condition may be recognised on rectal examination, whilst, when the prostate is involved, flocculi of mucus in the shape of worm-like threads may be detected in the urine. A patch of granular urethritis should be suspected when one portion of the urethra is especially tender on the passage of a sound, but its presence can only be recognised with certainty by the urethroscope.

Every purulent discharge is not necessarily gonorrhœal, since a simple urethritis may follow connection with a woman who is simply suffering from leucorrhœa, or has scarcely recovered from her menstrual period, but with no suspicion of a venereal taint. In these cases infection may be due to ordinary pyogenic cocci, or possibly to the *B. coli communis*, which is known to be not an unfrequent cause of vulvo-vaginitis. A diagnosis of simple urethritis may be suggested by the history, but only a microscopical examination of the pus, and a demonstration of the absence of gonococci, can establish it with certainty. It must be remembered, however, that gonococci are capable of remaining in a latent or passive state for a very long time in the folds or crypts of a mucous membrane, and hence a person who has once suffered from it may be capable of transmitting the disease, although no obvious evidence of its existence is present. Moreover, a highly acid condition of the urine in a gouty patient, especially if loaded with uric acid crystals, may light up into activity a urethritis which has been quiescent for some time.

In the **Treatment** of the early stages of acute gonorrhœa it is essential to keep the urine free from acidity by the use of alkalies, to maintain a free action of the bowels, and to allay the irritability of the parts by sedatives, such as tincture of henbane. The diet should be light and unstimulating, and all alcoholic drinks prohibited, as also strong tea and coffee, whilst the patient should be recommended to take plenty of bland fluids, such as barley-water, or milk and soda-water. The scrotum should be supported in a suspender, and the patient advised against taking severe or prolonged exercise. No local treatment is necessary, although the use of hot hip baths may relieve the pain and irritation, indeed, at this period injections are harmful. The same treatment must be adopted as long as the discharge is copious, and the scalding continues. As soon as these symptoms moderate, oleo-balsams in the shape of oil of sandal-wood (10 minims, in capsules, three to six times a day), copaiba (10 minims, in capsules or mixture, thrice daily), or cubebs ( $\frac{1}{2}$  to 1 drachm doses, wrapped in wafer-paper), may be advanced.



tageously employed Both cubebs and copaiba, especially the latter, are capable of producing a bright red erythematous rash which causes much irritation, and may be extensively diffused over the body

The value of *injections* in the treatment of the disease has been much discussed, and is a point on which difference of opinion exists On the whole, we are inclined to think that many of the less severe cases of acute gonorrhœa can be successfully treated without them, and that they should not generally be employed when marked local irritation or scalding is present, but when the discharge persists, or the urethra has become thickened by previous attacks, and especially in gleet, their use is imperative To employ them with advantage, the following plan should be adopted --The urethra is first washed out, so as to remove any discharge from it, for this purpose the normal act of micturition answers admirably, so that the injection should be used immediately after passing water The rounded nozzle of a small glass syringe, containing about half an ounce, is inserted into the meatus, the lips of which are compressed over it The fluid is thrown into the urethra, and held there for about twenty seconds by compressing the orifice with the finger and thumb, as the syringe is withdrawn, then, on relaxing the pressure, the fluid escapes Other forms of syringe, on the principle of the indiarubber bottle, etc., are recommended, but the glass is unquestionably the cleanest Of the many injections employed, one of the best consists of a mixture of tincture of catechu (10 minims to 1 ounce of water) and sulphate of zinc (2 grams to 1 ounce), but solutions of permanganate of zinc ( $\frac{1}{4}$  grain to 1 ounce), or nitrate of silver ( $\frac{1}{4}$  grain to 1 ounce), or protargol (1 per cent) are also very effective The great secret consists in using the injection four or five times a day at first, and afterwards night and morning, even after all visible signs of the discharge have ceased The fluid should always be warmed prior to use, and care taken not to use too strong a solution

One is bound to admit, however, that many genito-urinary surgeons hold views very different to these, and, indeed, maintain that gonorrhœa can be aborted, or, at any rate, rapidly brought under control at any stage by large injections of a weak solution of permanganate of potash, introduced with sufficient force to distend the urethra in all its parts and enter the bladder, all the crypts and lacunæ are thus reached by the antiseptic

The **Treatment of Gleet** is always a matter of difficulty The general habits of the patient must be attended to, as in the acute stage, whilst the bowels must be opened, and absolute sexual continence enjoined to prevent the spread of the infection Large doses of the liq ferri perchlor, combined with a sufficient amount of Epsom salts to prevent constipation, may be given Local treatment is generally necessary in the shape of injections as already described, and the passage of a cold solid metal bougie every three or four days has sometimes an excellent effect Methodical dilatation of the

urethra is also advised, with the object of compressing all the crypts and lacunæ, and removing pent-up secretion. If granular urethritis is present, the topical application of nitrate of silver may be undertaken through a urethroscope, but requires the greatest care, for fear of the subsequent formation of a stricture, chronic prostatitis and vesiculitis are dealt with by counter-irritation applied to the perineum, or possibly by sedatives, such as belladonna, administered in the form of suppositories.

**Complications of Gonorrhœa.**—These may be conveniently arranged under the following headings

**I Complications due to Direct Extension**—*In the male*, the following may be described

**Balanitis** is of frequent occurrence in patients with long foreskins. It is ordinarily due to pyogenic organisms, and not to gonococci. As a secondary result, inflammation of the lymphatics of the penis and inguinal bubo may follow.

**Lacunar Abscess** arises from infection of one or more of the lacunæ with the gonococcus or accompanying pyogenic organisms. A tense painful swelling forms along the floor of the urethra, which may project into the passage and discharge either into the urethra, or externally, or both, in the latter case a *penile fistula* will result. The abscess should be opened as early as possible from without, so as to prevent the latter occurrence, which is often very difficult to treat. If a fistula forms within a quarter of an inch or so of the meatus—a common situation—it seldom heals of itself, but may in some cases be closed by an application of the electric cautery or a weak solution of nitrate of silver. If, however, it remains intractable, the fistula should be laid open into the meatus. When it occurs in the body of the penis, a plastic operation is usually required, it consists in paring the edges and dissecting up the skin on either side so as to bring it together in the median line.

**Chordee** results from inflammatory infiltration of the corpus spongiosum or one of the corpora cavernosa, so that when the penis becomes erect, it is bent downwards or to one side, owing to incomplete distension of the infiltrated tissue. This condition is exceedingly painful, and most marked at night when the patient becomes warm in bed. It is best dealt with by applying cold to the part, and by administering bromide of potassium or opium at bedtime.

**Inflammation of Cowper's Glands** may in some cases give rise to deep suppuration in the perineum, with symptoms very similar to those of acute prostatitis. It is dealt with in the same way as the latter complaint.

**Acute and Chronic Prostatitis** (Chapter XXXIX)

**Acute and Chronic Vesiculitis** (Chapter XLI)

**Epididymitis** arises by extension along the vas, and will be fully described in Chapter XLI. It rarely commences before the third week, and often not until the fifth or sixth, being perhaps caused by

the injudicious use of injections, or by a blow or squeeze, especially if the scrotum is lax and pendulous

### **Acute Cystitis** (Chapter XXXIX)

*In the female*, the primary lesion is usually either in the urethra or in the cervical endometrium, or in both. In the former case the inflammation may spread to the bladder and cause cystitis, whilst in the latter extension may take place to the endometrium of the body of the uterus, the Fallopian tubes (salpingitis), ovaries, and peritoneum. In the latter case the inflammation is usually localized, producing adhesions round the fimbriated extremities of the tubes, which are an important cause of sterility, a general peritonitis may result, but this is unusual.

Gonorrhœal vaginitis is uncommon in the adult, and hardly exists as a primary lesion, it often happens that the pus and discharge from the cervix accumulate in the vagina and undergo septic decomposition. In this case the vagina may be inflamed by the direct action of the bacterial products, but its mucous membrane is not attacked by the gonococci. In children a true gonorrhœal vulvo-vaginitis occurs.

**II Complications arising from Direct Transmission of the Virus —**  
**Gonorrhœal Proctitis** sometimes results in the female from infection by the discharge which escapes from the vulva, whilst in both sexes it may be due to unnatural practices. It is characterized by tenesmus and a thick muco-purulent discharge, and is treated by injecting lotions of acetate of lead and opium, or of boric acid.

**Gonorrhœal Rhinitis** has also been seen in a few cases. It leads to an abundant discharge of pus, and should be treated by warm, soothing injections, followed after a time by dilute astringents.

**Gonorrhœal Conjunctivitis** occurs either in adults, when it is unilateral to start with, or in infants, when it is bilateral, and due to infection during transit through the maternal passages (*ophthalmia neonatorum*). It is a remarkable fact that, although gonorrhœa is so very prevalent, such a small proportion of the patients suffer from conjunctival infection, it would appear, therefore, that not only must there be direct contact with the gonorrhœal poison, but in addition the mucous membrane must be in a receptive state. In the adult variety it is ushered in by redness and irritability of the eye, followed quickly by a discharge which is at first mucous, but soon becomes purulent. The eyelids are red and swollen, the conjunctiva is thickened and œdematous (chemosis), and the discharge liable to accumulate within the conjunctival sac. If allowed to progress unchecked, the cornea may be injured by the inflammatory process, ulceration or even necrosis ensuing, and possibly general panophthalmitis. The first detail in the **Treatment** consists in protecting the opposite eye by means of what is known as Buller's shield, a watch-glass is fixed in a piece of mackintosh over the eye, and kept in position by plaster. The affected conjunctiva must be unremittingly attended to night and day, so as to prevent accumulation of discharge, it is frequently irrigated with warm boric acid.

lotion, and every four hours the membrane is carefully washed, dried, and swabbed over with a solution of nitrate of silver (5 grains to 1 ounce) Between the applications lint wrung out of iced boric acid lotion is kept over the eye This plan of treatment is continued until the suppuration ceases, and then the silver salt is omitted, and simple astringents, such as chloride or sulphate of zinc, substituted

In *infants* the disease often runs a rapid and severe course, and is very likely to lead to ulceration or sloughing of the cornea, a complication not uncommonly followed by escape of the lens and blindness Credé's preventive treatment should always be adopted for new-born children, viz., washing out the conjunctival sac with a weak solution of nitrate of silver or corrosive sublimate soon after birth When suppuration occurs, the treatment to be adopted is practically identical with that detailed above, except that it is useless to attempt to limit the trouble to one eye

**III Complications resulting from General Absorption**—**Gonorrhœal Affections of Joints** are not uncommon sequelæ, arising usually in the subacute stage of the disease They occur either in the form of a synovitis with effusion, or as an arthritis, which may or may not suppurate, but generally ends in ankylosis When suppuration takes place, only gonococci may be found in the pus, or they may be associated with other pyogenic organisms, and then the prognosis is decidedly worse, occasionally pyogenic cocci are alone present Not unfrequently the pus or serum from a gonorrhœal joint is found on examination to be free from germs, even on cultivation, the gonococci having died after causing the inflammation Such an occurrence is always suggestive, as sterile pus from an *acute* abscess is unlikely to be due to ordinary pyogenic bacteria For clinical features and treatment, see Chapter XXII

Any muscular, tendinous, ligamentous, or aponeurotic tissues may become inflamed and painful during the course of an attack of gonorrhœa Special mention must be made of the involvement of the ligaments supporting the arch of the foot, since, if the cause is not recognised and the patient is still allowed to walk, the arch of the foot may be lost, and a permanent flat foot result

**Gonorrhœal Scleritis**, or inflammation of the deep subconjunctival fibrous tissue, is a rare affection, arising quite independently of gonorrhœal conjunctivitis It is characterized by marked subconjunctival redness, the globe of the eye becoming distinctly tender Local applications of atropine are required, and, if need be, leeches to the temples

The pathology of the complications described in the last two paragraphs is uncertain They are probably due to the presence in the tissues of a small number of gonococci of enfeebled virulence, but it is also possible that they are caused by toxins absorbed from the local lesion

### Soft Chancre

A **Soft Chancre** is a local infective disorder, which is rarely seen elsewhere than on the genital organs, and is almost invariably the result of impure connection. It is due to a specific bacillus, which was first described by Ducrey. It is an extremely slender rod, which does not form spores or stain by Gram's method. It frequently occurs in short chains. The organism has been cultivated, though with difficulty, and there appears to be no doubt as to its causal relation to the disease. If artificially inoculated, it runs a typical course. The spot becomes a distinctly red papule in twenty-four hours, whilst in two or three days a vesicle, surrounded by a zone of angry hyperæmia, is seen. The serum within the vesicle soon becomes turbid, and by the fourth or fifth day a fully developed pustule is present, as soon as the cuticle is lost, an ulcer forms with cleanly-cut edges, and a sharp, distinct outline. The chancre gradually increases in size up to a certain limit, and then if kept clean heals in about three weeks. Such sores may be met with on any part of the penis, but more especially on the prepuce and glans, or on the corona glandis, and are very painful and tender. The secretion is highly infective, and if inoculated elsewhere on the patient produces a typical sore, showing that the condition is purely local, and that no constitutional immunity results from its presence. The discharge from a true syphilitic chancre, if inoculated on the same patient, may produce a localized pustule, but no typical sore. Frequently several sores are present at the same time, whilst the discharge from one chancre is very likely to produce a similar affection ('satellite' chancre) on any cutaneous or mucous surface brought into contact with it, *e.g.*, it may spread from prepuce to glans, or *vice versa*, or from one lip of the vulva to the other. It is a curious but well-authenticated fact that soft chancres are rarely seen on any part of the body other than the genital organs.

Various **Modifications** of the typical chancre are seen, usually resulting from neglect or carelessness on the part of the patient. Thus, if a long foreskin is present, the discharge may be retained behind it, and an extensive ulcerating balanitis occur, which may even result in the glans sloughing through the upper part of the prepuce, which drops beneath it. If the frænum is involved, smart hæmorrhage takes place from ulceration into a branch of the artery found in that structure. When there is much inflammation, the base of the sore becomes indurated and infiltrated, somewhat resembling the Hunterian chancre. Not unfrequently syphilitic infection occurs at the same time as a soft chancre is contracted, or subsequently, the sore is then likely to run a longer course, does not heal, even if kept clean, and after a time the patient presents the characteristic signs of syphilis.

In all cases the neighbouring **Lymphatic Glands** become enlarged and tender, and the process is very liable to terminate in suppuration, constituting a bubo. Two forms of this affection are described

(a) The *simple* or sympathetic bubo results from the absorption of ordinary pyogenic organisms from the abraded surface. The pus in this case, if inoculated elsewhere, may produce a pustule, but not a true chancre. The process is usually limited to the interior of the lymphatic glands. (b) The *virulent* bubo is one due to the absorption into the lymph stream, not only of pyogenic organisms, but also of the specific virus, so that when suppuration ensues, the pus, if inoculated, always produces a typical soft sore. In these cases the suppuration occurs not only within, but even more abundantly around the lymphatic glands (*peradenitis*), so that the skin becomes considerably undermined, and the wound produced by opening the abscess may take on the form of a huge soft chancre in the groin, in the centre of which may be seen the lymphatic gland only slightly enlarged.

The **Treatment** of soft chancre consists in keeping it clean, dusting its surface with iodoform, and covering it with lint dipped in lotio nigra or boric acid lotion, healing usually occurring in from ten to twenty days, where much balanitis exists it may be necessary to slit up the prepuce, but circumcision should not be undertaken until the sores have healed. The surface of the chancre may be treated with caustics, such as pure carbolic or nitric acid, and may perhaps heal quicker for such applications, but they need not be employed as a routine treatment, since soft chancres, if kept clean, are usually devoid of serious consequences. If the smell of iodoform is objected to, iodol or aristol may be substituted.

Buboes are treated in the early stages by keeping the patient at rest and applying fomentations, when resolution sometimes occurs. If suppuration ensues, the abscess should be incised vertically, so as to allow free exit to the pus, even when the patient is sitting, the cavity being subsequently dressed by stuffing it with gauze impregnated with iodoform. Some surgeons recommend that enlarged glands of this nature should be freely removed by dissection, but such is not required as a general rule.

We now come to a group of diseases which have been classified by Virchow under the term **Infective Granulomata**. They are all characterized by the formation of growths more or less resembling granulation tissue, which either persist or undergo various degenerative changes. They are all infective in nature, and most of them chronic in their progress, although acute manifestations are occasionally met with. Five conditions are included under this heading, viz. Syphilis, Tuberculosis, Glanders, Leprosy, and Actinomycosis.

### Syphilis

Syphilis is an infective disease resulting from inoculation with some specific virus, the nature of which has not yet been identified with certainty. Lustgarten demonstrated an organism in the initial lesion which was supposed to be the bacillus of syphilis, but it was

probably nothing more than that frequently present in smegma. The recent researches of Metchnikoff, Neisser, and others, who have found that the anthropoid apes, unlike all other animals, are susceptible to the disease, offer hopes that the infective agent may be discovered in the near future. These observers have already shown that the specific organism is not (as was formerly thought probable) of ultra-microscopic size, since it is unable to pass through a Berkefeld filter. It has also been shown that the virus is not present in the clear serum from the blood of syphilitic patients, and that this fluid was devoid of immunizing properties, since apes that had been treated with large quantities could be subsequently inoculated with the disease.

Syphilis is characterized by the appearance of a primary sore, usually known as a hard chancre, which is followed in the course of a few weeks by evidences of general infection, referred mainly to the skin and mucous membranes, comprising the secondary stage. After a variable time, known as the intermediate period, during which symptoms may be absent, tertiary manifestations may show themselves in any and every part of the body.

**Mode of Infection**—Acquired syphilis is almost always due to infection of the genital organs arising from impure connection. Occasionally cases are met with in which the disease is transmitted by other means (*syphilis insoutium*), and then the primary lesion is often located on some other part of the body (extragenital chancres), thus, the lip may be infected as a result of drinking out of the same glass or smoking the same pipe as a syphilitic patient, or even by kissing. The disease is not always equally infectious, in the primary stage the discharge derived from the chancre will alone convey the contagion, in the secondary period the virus is found in the blood of the individual, and hence all pathological exudations, as also the blood itself, may transmit the disease. Pure secretions, *e g*, milk or urine, are free from infection, although if mixed with a serous exudation from abraded surfaces, as so frequently occurs in the case of the saliva, they at once become infective. The semen is probably an exception to the above rule, since, although the maternal passages may entirely escape, the ovum becomes diseased. It is usually held that in the tertiary stage the patient is no longer capable of transmitting the affection.

The syphilitic virus is exceedingly resistant to the action of antiseptics, and hence the risk of infection is very great, even though prompt measures are taken to destroy it. Thus, many cases are on record in which an abraded surface was brought into contact with a syphilitic poison, and, although cauterized with fuming nitric acid within a few hours, the disease ran its ordinary course. In one case, however, under our observation, in which a student's finger was accidentally pricked with a bent broad needle, which a moment before had been inserted into the anterior chamber of a syphilitic patient suffering from a secondary suppurative iritis, nitric acid was applied within a quarter of an hour, and although a suspicious

indurated spot formed six weeks later at the site of injury, no other evidences of syphilis have been observed, in spite of the fact that the individual had not previously suffered from the disease, and took no mercury

One attack of syphilis usually confers immunity on the patient from further outbreaks of the disease, even if exposed to infection. This protection is not always permanent since well-authenticated cases have been observed of second attacks of syphilis, in which the primary lesion was on each occasion followed by distinct signs of general infection

**Course of the Case** —The stage of Incubation lasts for a variable period, extending from two to six weeks, as a rule evidences of induration of the sore can be detected about the third week. It is probable that long ere this the virus has entered the circulation, and hence removal or destruction of the local lesion has not the slightest influence upon the progress of the case, unless it can be undertaken immediately after infection. During this period the local sore may heal completely, if it is purely syphilitic, and nothing further is noticed until the typical induration manifests itself. Not unfrequently, however, pyogenic infection occurs or a soft chancre is also present, in the latter case the lesion does not heal satisfactorily, and the base of the ulcer becomes indurated after a time

**I The Primary Stage** of syphilis is characterized by the development of a typical primary sore, associated with enlargement of the neighbouring lymphatic glands. It is usually situated on the base of the prepuce, close to the corona glandis, or on the frænum, in the female the inner aspects of the labia majora or nymphæ are the most common sites

The primary sore does not invariably present the same appearance, although it is always characterized by a certain amount of infiltration and induration. Should the superficial abrasion have healed, a localized growth of almost cartilaginous hardness forms in the cicatrix, closely adherent to and invading the cutis, but if a soft sore has first developed, the surface remains ulcerated more or less deeply though the base becomes indurated. The following are the chief forms in which the chancre manifests itself. (a) The *desquamating papule* is a slightly elevated spot, which is extremely irritable of a dusky colour, and free from ulceration. It is usually small, but hard, and its surface covered with epithelial scales. If exposed to friction or to the irritation of retained discharges, ulceration is very likely to take place, and an ordinary Hunterian chancre will then form. Unless this occurs, it may run its course unobserved, and thus a patient becomes syphilitic without being able to trace the time or source of infection. (b) The indurated, hard, or *Hunterian chancre* is that most commonly seen, it results from the irritation of a papule, or is developed in association with a soft sore. It consists of a distinctly localized infiltration and induration of the submucous or subcutaneous tissues, giving rise to a lump which feels like a pellet of cartilage, or the induration may be more extensively



diffused through the surrounding structures. In some cases there may be but little elevation of the growth, and the surface is free from ulceration, constituting the variety known as the 'parchment induration' of Ricord, and not unfrequently seen on the glans penis. Where, however, the prepuce or body of the penis is involved, greater induration takes place, owing to the laxity of the connective tissue. When affecting the base of the prepuce, the induration usually spreads transversely, producing a collar-like mass, which on retraction of the part rolls back *en bloc* in a very characteristic manner. Examined microscopically, the new formation consists merely of a mass of round and spindle cells packed closely together, with a certain amount of intercellular fibrous tissue, giant cells are sometimes seen. The blood-supply of the part is scanty, a fact which explains the readiness with which ulceration occurs. Several chancres may be seen on the same individual if the infection occurs at one time, and it is possible that a patient could be infected at two different periods if only a short interval elapsed between the inoculations, but the disease is not generally auto-inoculable, and when once a hard chancre has developed on the under surface of the prepuce, the glans does not become infected from contact. Multiple chancres are always of small size, and the induration is less marked than usual.

A **Urethral Chancre** is usually situated just within the lips of the meatus, constituting a sore with an indurated base. It may be felt as a hard nodule on grasping the urethra between the fingers, and gives rise to a thin serous discharge, often blood-stained. The orifice itself is sometimes the site of a chancre, and the induration may completely encircle it. This condition is very apt to be followed by a stricture.

**Extragenital Chancres** are most commonly observed on the lips, finger, and nipple. They are usually characterized by a greater amount of infiltration and less distinct and definite induration than in the forms met with on the genital organs, hence the swelling is more prominent and vascular, and if ulceration occurs there is a greater amount of discharge, which forms a thick scab over the surface. The neighbouring lymphatic glands are enlarged, and sometimes surrounded by infiltrated tissue. This condition has often been mistaken for epithelioma, from which, however, it can be distinguished by the character of the sore, its rapid development, and the earlier enlargement of the glands. The course of the case is generally more severe than when the primary lesion is in the usual situation, a fact possibly explained by the disease remaining unrecognised till secondary symptoms appear.

**Digital chancres** are usually seen in surgeons and accoucheurs, and start by the side of the nail. An indolent sore appears, which becomes infiltrated and ulcerates, spreading under the matrix and along the semilunar fold. There is a good deal of discharge and pain, and the terminal phalanx becomes swollen and bulbous. The epicondyloid and axillary glands are enlarged as the case progresses,

and the condition has more than once been mistaken for malignant disease

**Phagedena** is a form of spreading ulceration, rarely met with at the present time, except in connection with venereal disease and seldom apart from syphilis. It always attacks unhealthy and debilitated individuals, especially men with phimosis. The discharge, often abundant and sometimes offensive, is retained under the long foreskin, which together with the end of the organ becomes red, swollen, and infiltrated. On dividing or retracting the foreskin, the affected surface is found to be sloughy, and the ulceration, unless checked by treatment, rapidly spreads, and may destroy glans and prepuce, and even attack the body of the penis. A similar condition is occasionally seen in connection with an

then the integrity of the femoral vessels is threatened. It consists in division of the foreskin if that structure has not been already destroyed, followed by prolonged immersion of the patient in a hot hip-bath. If the patient cannot be kept for twelve or twenty-four hours in a warm bath, it will suffice to immerse him in warm water for two or three hours every day. In the intervals the wound should be dusted with iodoform, and dressed with lint dipped in *lotio nigra*. Under such circumstances, the surface of the sore quickly cleans, and becomes covered with healthy granulations. The later treatment is conducted as for primary syphilis, although the depressed condition of the general health may necessitate the administration of tonics and even a visit to the seaside. Should treatment by immersion in hot water be for any reason impracticable, the old-fashioned plan must be resorted to, viz., scraping the sore, and freely cauterizing the base with pure carbolic or fuming nitric acid. Possibly, where there is much slough, this may advantageously precede immersion in a bath.

The **Lymphatic Glands** which receive lymph from the region in which the sore is situated become characteristically enlarged. They move freely under the skin and feel hard, like bullets, pellets of cartilage, or almonds (hence the term 'amygdaloid' which has often been applied to them), they are usually quite painless, and there is no tendency for them to suppurate if the infection is purely syphilitic, but if the original sore is septic, or also inoculated with the virus of a soft chancre, an abscess often follows, one or more of the inguinal glands breaking down, and causing a painful, red, and brawny infiltration of the superjacent integument. After a time the skin gives way, and is often found extensively undermined.

Occasionally the lymphatic vessels extending from the sore to the glands become the seat of a chronic lymphangitis, and may be felt as hard cords beneath the skin. The dorsal lymphatic of the penis is frequently blocked in this way, and gives rise to solid or lymphatic oedema of the prepuce and glans. Should the chancre suppurate, an abscess may form in the course of the lymphatics.

The **Diagnosis** of a syphilitic from a soft sore is not always easy. Of course, where there is no ulceration, and the typical induration of the base can be felt, no doubt need arise. But when the primary sore is septic, and an excavated ulcer is present, surrounded by infiltrated and hyperæmic tissues, it is difficult to be certain as to the nature of the case. The inguinal glands are enlarged in both varieties, and the fact that suppuration occurs proves nothing. Even the existence of a 'satellite' chancre from auto-inoculation only demonstrates the presence of a soft chancre, it does not prove the

absence of syphilis. In such cases it is often necessary to wait for the development of secondary symptoms before a decided opinion can be given. For Justus's test for syphilis and its value, see p 45.

The **Duration** of the primary sore varies in different cases, and depends in great measure on whether treatment is commenced early or late. If the case comes under observation during the first six weeks, and a mercurial course is at once started, the chancre heals, and the induration usually disappears in from six to eight weeks. The glands in the groin, however, remain enlarged for some time. The longer the case is left untreated, the more slowly does the hardness disappear. If no mercury is given, the induration may last for twelve months or more, and then slowly passes off, although it may run a much shorter course. From an uncomplicated syphilitic sore but little scar results, although a well-marked cicatrix may follow a soft or septic chancre.

Re-induration of the cicatrix sometimes occurs from too early a cessation of the mercurial course, or from some localized irritation, or from a fresh exposure to infection. It is occasionally due to a tertiary or gummatous development, and will then be free from lymphatic complications.

**II Secondary Syphilis**—In the secondary stage, the virus is diffused generally throughout the body by means of the blood, which is itself infective. A certain amount of constitutional disturbance may exist, the patient feeling 'seedy' and out of sorts, whilst in some cases distinct febrile phenomena and headache have been noted. Well-marked anæmia is often present, and on examination the red corpuscles are found to be deficient in number, and defective in the amount of hæmoglobin contained within them. The chief secondary manifestations consist in the appearance of various forms of rash on the skin and mucous membranes, associated with a general enlargement of the lymphatic glands, sore throat, mucous tubercles and condylomata, loss of hair, and other less common phenomena, and these usually show themselves in from seven to nine weeks from the time of inoculation, although they may be delayed to a much later date. Their intensity also varies considerably, the phenomena being sometimes scarcely evident, and at others very marked. They are also influenced greatly by the period at which the administration of mercury commences, the earlier the drug is given, the less obvious are the secondary phenomena.

The **Cutaneous Eruptions** of secondary syphilis are chiefly characterized by the fact that, although any form of rash may be simulated, no specially distinctive variety is originated. Moreover, in the same individual the eruption is not always of the same character throughout, several distinct types developing in different parts of the body (*polymorphism*). The rash is usually more or less symmetrical, the colour in the early stages being a dusky red, resembling that of raw ham, whilst later on it becomes of a more coppery hue, occasionally, however, it may be a bright rosy red. Syphilitic rashes do not completely fade on pressure, but leave a

brown stain, and give rise to but little irritation or itching, they always tend to progress from the simpler types, due to hyperæmia, to the more serious, in which infiltration and overgrowth are evident

In the simplest form, merely a hyperæmia is present, sometimes appearing as a dusky mottling of the skin (*roseolous* syphilide), which quickly fades or may persist whilst other types are developing. If distinct papillæ become infiltrated and hyperæmic, a *papular* syphilide is said to be present, such may become either vesicular or pustular, constituting the *vesicular* or *pustular* syphilides, the latter change is uncommon, and only appears in bad cases or in debilitated patients. Another form of eruption is the *squamous* syphilide, characterized by patches of hyperæmia and infiltration, combined with superficial desquamation. It is usually bilateral, and, unlike simple psoriasis, affects the flexor rather than the extensor surfaces. In the later stages, distinct nodules or tubercles are produced in the skin, which may even run on to ulceration (*tubercular* syphilide)

As to the *situation* of the rash, the roseola is usually limited to the abdomen, whilst the other forms are often widely scattered over the trunk and extremities, involving, however, the flexor more than the extensor surfaces of the limbs. A somewhat characteristic phenomenon is the appearance of a papular rash on the forehead, sometimes known as the *corona Venereis*

The **Mucous Membranes** may be affected in much the same way as the skin. The fauces become red and congested, the hyperæmic area being abruptly limited, and semicircular in outline, symmetrical ulceration usually follows, starting near the anterior pillars of the fauces, and spreading to the tonsils and along the soft palate to the uvula. These ulcers are shallow, have sharply-cut edges, and often present a characteristic grayish appearance, constituting what is known as a 'snail-track' ulcer. The secondary sore throat rarely results in extensive loss of substance, and hence pharyngeal stenosis is not common at this period of the disease. Smoking undoubtedly aggravates these conditions. Concurrently with these manifestations in the fauces bare patches from loss of epithelium may be seen on the dorsum of the tongue, or several small superficial, but very painful, ulcers may develop on the inside of the cheeks or lips.

Mucous tubercles and condylomata are somewhat similar affections, though more pronounced, arising in the secondary stage in connection with mucous membranes and those parts of the skin which are soft and moist. **Mucous Tubercles** consist of slightly-raised patches of enlarged and infiltrated papillæ, white in appearance from the superficial epithelium becoming sodden, and often progressing to actual ulceration. Examined microscopically, the papillæ are found to be definitely enlarged, and the epithelium heaped up over them. They are most commonly observed at the corners of the mouth, on the inner aspect of the cheeks, the side of

the tongue (often due there to the irritation of rough teeth), or the margin of the anus, in the last-named situation they are usually symmetrical, one side being infected from the other. They are also not at all uncommon between the toes, and the ulcers caused thereby become exceedingly offensive from septic contamination. **Condylomata** are similarly the result of overgrowth of the papillæ, differing from mucous tubercles merely in the extent to which this has been carried. They consist of definite wart-like masses, which may attain a great size, constituting a cauliflower-like growth. They are most commonly seen about the anus or vulva, in the former situation being often mistaken by the patient for piles, they give rise to an abundant, highly infective discharge. A similar condition is sometimes met with on the dorsum of the tongue, and is then known as 'Hutchinson's wart'.

The **Lymphatic Glands** are usually enlarged throughout the body during this period of the disease, being felt as round, hard swellings beneath the skin. The extent of the glandular complication is possibly a measure of the degree of virulence of the affection. The condition of the nuchal and epicondylar glands should always be ascertained in suspicious cases, since, if no obvious local cause exists for their enlargement, syphilis is very probably present.

**Syphilitic Alopecia**—The hair becomes dull and lustreless, and either comes out in patches from the scalp, eyebrows, beard, etc., or there is a general 'thinning'. The follicles, however, are not destroyed, and after a time the hair will grow again as before.

Later secondary manifestations consist of flying pains in the bones (osteocopic), iritis, and various nervous lesions, whilst periosteal nodes may form on the tibiæ and other bones, or a symmetrical chronic effusion develop within the synovial membrane of joints.

**Syphilitic Iritis** is characterized by pain in the eye, generally referred to the supra orbital nerve, together with some interference with vision, and possibly a little lachrymation and photophobia. On examination a bright-red circular zone immediately surrounds the cornea, resulting from hyperæmia of the ciliary vessels. The iris is lustreless, and its definition somewhat blurred. Its colour is changed, a blue iris becoming greenish-yellow from the presence of lymph. The pupil is diminished in size, and perhaps irregular, its movements are always considerably hampered, and sometimes entirely prevented, by the formation of adhesions either to the back of the cornea (anterior synechiæ) or to the lens capsule (posterior synechiæ). Occasionally small yellowish nodules are seen on its surface, consisting of plastic lymph.

The **Duration** of the secondary stage varies considerably, and is largely influenced by the character of the treatment and the period at which it is commenced. The sooner the patient is brought judiciously under the influence of mercury, the less severe the secondary phenomena, whilst cases in which treatment has been delayed are likely to be more troublesome. Hence the disease is

often of an aggravated type when following extragenital chancres, as also in women, by whom the primary lesion often passes unnoticed. When treatment is commenced within four or five weeks of infection, the secondary stage may be slight, and all traces of its existence may pass off in two months or less, if mercury is not administered until the cutaneous eruption has appeared, this stage is likely to last longer. The condition of the patient's health is an important factor, as also the previous habits, particularly as to temperance, since syphilis always follows a more aggravated course in the weakly and the dissipated. Even under the best circumstances, the patient is liable to outbreaks of the affection within the first twelve months. *Relapses* are by no means uncommon, being



FIG 19—RUPIA OF FACE (FROM WAX MODEL IN MUSEUM OF ROYAL COLLEGE OF SURGEONS)

usually due to intermissions in the treatment. The rash which appears under these circumstances is often of a more characteristic type, the papules being grouped into rounded or corymbose figures.

III The Intermediate or late Secondary Stage comprises a group of symptoms which form a link between those already described and the tertiary phenomena, and, indeed, no distinct limits to this period can be defined, nor need it appear at all if the patient's general health is good, and the treatment has been carried out regularly. Some of the secondary manifestations, especially those of the bones and joints, may persist through this period, whilst even if they have disappeared, the patient is liable to suffer from 'reminders' in the shape of various cutaneous affections and

perhaps epididymitis. Deep lesions of the eye (choroido retinitis) and of the central nervous system (syphilitic monoplegia) are not uncommon, the latter usually arising from anæmia of the cerebral centres due to a syphilitic endarteritis. The principal cutaneous affection is the so called **syphilitic psoriasis**, most frequently seen on the palms and soles. A squamous syphilide is often observed in the secondary stage, but is then symmetrical and readily influenced by mercury. In this intermediate period, the lesion may be bilateral or limited to one side, according to whether it appears early or late. In the former there is a considerable tendency to proliferation of the epithelium, together with deep cracks and fissures, in the latter there is less epithelial overgrowth, but the edges are often distinctly serpiginous in outline, and there is an infiltrated border.

**Rupia** and **Ecthyma** are both met with in this stage of the disease. They are characterized by an infiltration of the skin, which progresses to ulceration. In rupia the discharge forms a distinct scab on the surface, which increases in thickness by the deposit of successive layers one under the other, each being somewhat larger than the one which precedes it, hence a scab shaped like a limpet-shell is produced, resting on an inflamed and hyperæmic base (Fig 19), any part of the body may be affected in this way. In ecthyma no scab forms over the ulcerated surface, or, if formed, it readily comes away, leaving exposed a hollow punched-out sore, surrounded by an area of vivid congestion. Under appropriate treatment these conditions disappear, but leave depressed, whitish cicatrices, often surrounded by pigmentation.

A somewhat unusual intermediate manifestation is a subacute symmetrical epididymitis, in which the cord also becomes thickened, enlarged, and tender.

**IV Tertiary Syphilis**—The phenomena occurring in this stage may appear within six months of infection, or not for twenty or thirty years. They are mainly characterized by infiltration and overgrowth of the connective tissues of the body. Such may occur in one or many places, and may be diffuse or localized. In the former case the organ or part affected becomes enlarged, hard, and sclerosed, and unless the condition is treated promptly, the normal tissue of the part may entirely disappear, being replaced by fibro cicatricial tissue. If, however, the process is localized, a **Gumma** is formed.

Any tissue in the body may be the seat of a gummatous deposit, which apparently arises without any definite cause, although occasionally its onset may be determined by an injury. The involved area becomes occupied by a cellular infiltration, the component cells of which are partly large oval epithelioid cells, and partly small round cells (lymphocytes), plasma-cells are usually present in considerable numbers. The constituents of this mass are quite similar to those which are found in a tubercle, but without the grouping into small nodules and the more or less orderly arrangement in zones,

giant cells are usually absent, though their presence is by no means rare, and they may closely simulate the tuberculous type. This structure gradually increases in size, infiltrating and replacing the normal tissues of the part. Very few vessels penetrate into the mass thus formed, which otherwise resembles granulation tissue. The fate of the fully-formed gumma varies according to circumstances. If the infection is a mild one, and especially if appropriate treatment is adopted, a certain amount of organization into fibrous tissue may take place, and the bulk of the cells may become absorbed, so that even a large gumma may almost entirely disappear, a small fibrous scar being the only indication of its occurrence.

In the absence of proper treatment most gummata undergo a necrotic change. This may be a comparatively slow process, so that fatty degeneration has time to occur, in which case it closely



FIG 20 — CUTANEOUS GUMMATA ON OUTER SIDE OF THIGH

resembles the caseation seen in tubercle, or it may be a more rapid form of coagulation-necrosis, in which the tissues undergo a kind of mucoid degeneration, forming a gummy mass from which the lesion acquires its name. In either case the necrotic process commences in the centre of the nodule and extends until it involves the whole of the mass except the growing edge which is spreading into the normal tissues of the part. Sections through such a gumma will show a large white structureless mass of necrotic or caseous material, surrounded by a shell of cellular tissue, which gradually merges into the normal structure of the part. Two factors are concerned in the production of this necrosis—the toxins produced by the causative bacteria and the deficient blood supply of the central portions of the cellular mass. The vessels of the gumma are deficient from the first, and after a time the amount of blood which reaches them is diminished as the result of a syphilitic endarteritis of the arterioles in the neighbourhood. Moreover, some gummata do not commence



to undergo central necrosis until a certain amount of transformation into cicatricial tissue has taken place, in which case a still further interference with the blood-supply may be caused by the compression of the vessels traversing the newly-formed fibrous tissue

Under appropriate treatment the whole of the gummatous mass may be absorbed, even where caseation or necrosis has taken place, but not unfrequently the gummy, semi-purulent fluid which is formed at the centre of the mass finds its way to the surface and is discharged. Where the necrotic mass is large, a portion of it may remain adherent to the surrounding tissues after ulceration has taken place, looking somewhat like a piece of wet wash-leather. Under exceptional circumstances the central slough may become encysted by the formation of a fibrous capsule, and calcification of the centre may even occur, this is stated to be most frequently found in the brain, testis, and liver

Clinically, the appearances vary according to whether the gumma is cutaneous or subcutaneous

*Cutaneous gummata* (Fig. 20) are very frequently observed in tertiary syphilis, especially in the earlier stages. They occur as dusky-red nodules of firm consistency, and but slightly painful. Many such growths are often grouped together in one region, and when ulceration has occurred, they produce by their confluence sores with a rounded or serpiginous outline. Considerable destruction of tissue follows, but they are readily cured, giving rise to depressed white cicatrices, surrounded by pigmentation. Any part of the body may be involved, but a very common site is about or just below the knee, on the outer, rather than the inner, aspect of the leg

Occasionally a diffuse infiltration of the skin is met with in this stage, appearing as a red hyperæmic area with a rounded or serpiginous border, and not at all unlike lupus in appearance. It is readily amenable to treatment, and runs a much more rapid course than lupus, the edge is usually thickened to the same extent all round, and there is but little tendency to the formation of outlying nodules. The apple-jelly-like granulations so typical of lupus are of course not present. A cicatrix is usually produced, even if ulceration has not taken place

A *subcutaneous gumma* develops as a firm nodule or an indefinite thickening, which gradually increases in size by the infiltration of surrounding tissues, and sooner or later approaches the surface, the centre of the tumour in time becomes elastic and fluctuating, a certain amount of pain and tenderness is noticed, and when the skin is affected, it becomes dusky and even œdematous. If ulceration follows, the contents of the gumma escape, and the sore produced is deep, the edges being sharply cut and perhaps undermined, the base of the ulcer consists of granulation tissue, although it is sometimes covered by the characteristic slough

The peculiar features of tertiary syphilis, as it affects special regions, will be described under the appropriate headings *vide*

syphilitic diseases of arteries, of lymphatic glands, of muscles, of bones, of joints, of the lips, of the pharynx, of the tongue, of the larynx, of the rectum, of the testis. The symptoms arising from gumma of the brain will be alluded to in Chapter XXVI, but the general relation of syphilis to the nervous system has been purposely omitted, since it belongs rather to the physician than to the surgeon.

The **Prognosis** of syphilis is good if the patient comes under treatment at a sufficiently early stage, and if he has no idiosyncrasy which prevents the administration of mercury or iodide of potassium. In persons suffering from extragenital chancres, which are not recognised till late, the disease often runs a more than usually severe course. The general health of the patient, and perhaps a peculiar predisposition, may influence the evolution of the case, whilst the co-existence of tuberculous disease may render the prognosis peculiarly unfavourable, especially when the disease is inherited. The character of the rash, and the extent of the general glandular enlargement in the secondary stage, may perhaps give some indication of the gravity of the case, where the eruption is but slightly marked, the other symptoms are usually mild, whilst a pustular eruption is almost always of grave import. Death is rarely produced by any of the secondary manifestations, but may occur in the tertiary stage, when important viscera, such as the brain, spinal cord, liver, etc., are involved.

As to the **Curability** of syphilis, the general opinion held at present is that, if the disease is seen early, and treated satisfactorily, the patient will in all probability never suffer from any further manifestations after the secondary symptoms have disappeared. A cure can, however, never be definitely promised, since, should the general health of the patient become impaired, characteristic syphilitic phenomena may make themselves evident even thirty or forty years after the primary lesion. There is also no doubt that certain cases are to be looked on as absolutely incurable, owing probably to the fact that they were not brought under treatment until tertiary phenomena were present, such are usually seen amongst females.

The **Treatment** of syphilis consists in the administration of mercury during the primary and secondary stages, and of iodide of potassium, with or without mercury, in the late secondary and tertiary periods.

Many different methods have been suggested for the *administration of mercury*, in order that the patient may derive the greatest amount of benefit from the drug with the minimum of inconvenience. (a) It is usually given *by the mouth*, either in the form of pills composed of gray powder (grs 1—11, t d s), or of the green iodide (gr  $\frac{1}{2}$ —1, t d s), or as a mixture containing a solution of corrosive sublimate. The last method is distinctly objectionable, inasmuch as its prolonged use in sufficient doses disturbs the digestion. Gray powder is perhaps the best means of giving the drug, the patient should commence with 2 grains, given three times a day, or in some cases  $1\frac{1}{2}$  grains

four times a day, combined with a little extract of opium or pulv ipecac co if there is any tendency to diarrhœa, but this addition is not always needed. This should be cautiously continued until all prominent signs of the disease have disappeared, and then the dose is gradually reduced. (b) *Inunction* of the mercurial ointment is also frequently adopted, and with great success, inasmuch as it is less likely to cause digestive derangements. If the ordinary official ointment is employed, a portion as large as a hazel-nut is rubbed into the groin or axilla nightly, the part being washed the following morning, and not used again for this purpose for three or four-days, if the ointment is made up with lanoline, a somewhat smaller amount is required. Possibly this is one of the best ways of bringing a patient rapidly under the influence of the drug. (c) *Mercurial vapour baths* may be advantageously employed where the cutaneous eruption is very extensive. The patient sits naked on a cane-seated chair, and covered with a blanket or specially constructed cloak reaching from the neck to the ground, and not touching the body, 20 or 30 grains of calomel are placed on a metal plate surrounded by a trough containing about 1 ounce of water. The water is boiled, and the calomel sublimed, by means of a spirit-lamp placed under the chair. In about twenty minutes all the calomel will be volatilized, and deposited in part upon the skin of the patient, who perspires freely during the process. He then gets into bed between warm blankets, without wiping the skin. This treatment may be combined with medication by the mouth. (d) Mercury is sometimes administered by subcutaneous injections, in the form of the perchloride,  $\frac{1}{2}$  grain or less being injected once or twice a week into the substance of the gluteus maximus. A little thickening of the site of injection results, but quickly passes away, and suppuration scarcely ever follows. The succinamide is another useful salt for this purpose, a 2 per cent solution is employed, and the usual dose is from  $\frac{1}{8}$  to  $\frac{1}{4}$  grain injected into a muscle every two or three days, it is well borne and causes no irritation.

During the course of mercury, the patient's general health and habits must be carefully regulated, all excesses in drink and diet being forbidden, and strict instructions given as to keeping the teeth and gums clean. To minimize the risk of throat and mouth trouble, it is wise to stop all smoking for at least six months. The dose required varies in different individuals, being increased in robust people, and diminished in those who are weak or unhealthy. It should always be pushed until mild physiological effects are produced in the shape of slight tenderness of the gums, but salivation of the patient is undesirable. Full doses are usually required for four or five months, followed by a milder course, which should extend till the end of the first year.

Symptoms of excessive *mercurialism* are generally induced by over-doses of the drug, but in some people a very small dose suffices to produce severe effects, hence treatment should always commence with small doses. When mercury is producing toxic effects, the

gums become soft and spongy, and bleed readily on pressure. Salivation follows, and even acute glossitis may be produced, whilst the breath becomes offensive. In worse cases the teeth are loosened, and necrosis of the alveoli has followed. Derangements of the digestion, in the shape of colicky pain and diarrhoea, are also observed. The treatment of this condition consists in suspending the administration of the drug for a time, and giving a sharp saline purge, whilst the spongy state of the gums is remedied by the use of an alum or chlorate of potash mouth wash.

Iodide of potassium is essential in the treatment of the tertiary and intermediate stages. It appears probable that its chief action is the removal of gummatous tissue, and that it has little influence upon the causative disease, in order to prevent recurrence, mercury is still required. The dose of iodide should not exceed 5 grains to start with, and is gradually increased until in some cases 1 drachm four times a day has been reached. A feeling of depression and sinking at the epigastrium is often produced, but may be alleviated by the addition to the mixture of sal volatile (℥ ℥) or carbonate of ammonia, as suggested by the late Sir James Paget. Symptoms of coryza may follow, and an acneiform eruption over the shoulders and face, which, however, often disappears on increasing the dose. Sometimes a vesicular, or even bullous, rash is caused by this drug. When large doses are given, bicarbonate of soda or potash must be combined with it, in order to prevent its decomposition by the gastric juice, and plenty of water should always be taken immediately afterwards to assist in its dilution and facilitate its absorption. The iodides of sodium and ammonium are sometimes substituted for the potassium salt, on the plea that they give rise to less depression.

Other drugs, such as sarsaparilla and iron, are often combined with iodide of potassium in the later stages of the disease, and may be useful.

The **Local Treatment** of syphilitic sores consists mainly in the application of various preparations of mercury. The *primary chancre* is usually treated with lotio nigra on lint, iodoform being sometimes employed if septic ulceration is present. *Mucous tubercles* in the neighbourhood of the anus or vulva, or between the toes, are best dealt with by keeping them scrupulously dry and clean and dusting them over with powdered calomel, or by the application of calomel ointment, a piece of lint being inserted between opposing surfaces to keep them from rubbing one against the other. Secondary ulceration of the *throat* does not usually require local treatment, as it soon disappears under the influence of mercury. A mercurial gargle may, however, be employed, or in bad cases calomel may be placed on a hot copper coin, and its vapour inhaled. *Superficial gummatous ulcers* are treated by removing the scabs, and applying some form of mercurial ointment. A determined attempt should be made to keep deep gummatous ulcers in an aseptic condition, since the advent of sepsis to such sores, especially if they are connected with bones, makes a marked difference in their progress. In neglected cases the

wound may become exceedingly foul, and in chronic cases a hectic temperature and amyloid degeneration of the viscera have been observed. When gummata come to the surface and point, they should be opened with the same precautions as are adopted in the case of an abscess, and either dressed antiseptically or their cavity packed with sterilized lint or gauze soaked in sterilized lotio nigra.

### Inherited or Congenital Syphilis

Syphilis may be conveyed to the ovum either by direct transmission from the father or mother alone, or both parents may be tainted with the disease. Occasionally the mother acquires syphilis during pregnancy, and in such cases the foetus also becomes affected. In those instances where the ovum is infected from the father, whilst the mother has escaped, the latter becomes in measure protected, so that, if the child is put to her breast, she does not contract the disease, even though there are ulcerating lesions on the child's gums and lips, healthy wet nurses are invariably infected (*Colles's Law*). Whether the immunity is permanent or not is still a matter of uncertainty, and even the inviolability of this law has recently been called in question. The immunity of the mother has been attributed to the production of antibodies in the foetus and their passage into the maternal blood, but the recent researches of Neisser on the higher apes seem to disprove the existence of such substances, it is more probable that the mother owes her immunity to a mild and unrecognised infection with the disease itself. *Profeta's law* is the reverse of Colles's, and asserts that the child of a syphilitic mother or father is immune to syphilis, although it has never presented evidences of infection with the disease.

The length of time during which a patient retains the power of transmitting the disease to the foetus is an exceedingly difficult point to determine, and one which is constantly coming before the practitioner, who is asked to decide at what period it is safe for a syphilitic patient to marry. The rule of practice generally followed is that no one suffering from syphilis should be allowed to marry until he or she has been free from all symptoms for at least twelve months, and even then it is advisable that a mild course of mercury should be given for about three months shortly before marriage.

A syphilitic foetus often fails to arrive at maturity, the mother miscarrying at the end of six or seven months. This is probably due to a specific affection of the endometrium, especially involving that portion of the decidua which enters into the formation of the placenta. The circulation and nutrition of the foetus are thereby impaired, so that it is usually born not only dead, but in many cases macerated and partially decomposed. This may be repeated for several pregnancies, and then a living child is produced. In many cases, however, a living child is born at full time at the end of the first pregnancy, in spite of the syphilitic infection of the parents.

At birth the child often appears healthy and well nourished, but is sometimes small and imperfectly developed. The first definite symptoms of the disease manifest themselves at a variable period, extending from three weeks to three months, after birth, the child becomes thin and emaciated, the skin, which hangs in wrinkles over the body, changes to a dull earthy colour, whilst the features looked pinched and wizened, like those of an old man. Marked anæmia is always present, and may persist for a considerable time. Speaking generally, the symptoms of inherited syphilis are similar to those of the acquired disease, except that the primary lesion is absent. Thus, during the first year of life the child develops various cutaneous eruptions, mucous tubercles, and superficial ulceration of the mucous membranes. A dusky red roseola, especially about



FIG 21 —CHILD WITH INHERITED SYPHILIS, SHOWING RADIATING SCARS ROUND THE MOUTH (FROM A PHOTOGRAPH KINDLY LENT BY DR G F STILL)

the nates (napkin area), may first be noticed, but does not last long. This is usually followed by the appearance of mucous tubercles at the angles of the mouth, in the nose, and around the anus, as also in the moist folds of the groin, and between the scrotum and thigh. The sores on the lips are sometimes very marked, giving rise to ulcerated surfaces, which, by their subsequent cicatrization, leave radiating scars (or rhagades), especially about the angles of the mouth (Fig 21). Other cutaneous affections, such as squamous syphilides of the soles of the feet, together with papular syphilides of the body, and a bullous eruption becoming pustular (pemphigus), are also observed, the last mentioned, however, only occurring in debilitated infants. A catarrhal rhinitis is a very early and constant manifestation, giving rise to obstructed nasal respiration, or *snuffles*

This affection is often protracted, going on to ulceration and destruction of the nasal bones and cartilages, their subsequent development is thus prevented or impaired, and hence the bridge of the nose remains depressed and sunken, even when adult life is reached (Fig 22) Enlargement of the spleen and liver is also common

Many infants during the first year of life die from malnutrition or marasmus, but if properly treated a considerable proportion regain their health within six or eight months, all the manifestations described above disappearing, although their scars may remain



FIG 22 — HEAD AND FACE OF A PATIENT WITH INHERITED SYPHILIS, SHOWING DEPRESSED BRIDGE OF NOSE AND FRONTAL BOSSES (FROM A PHOTOGRAPH)

The child's subsequent development is frequently impaired, and it often retains an almost pathognomonic facies

After the first year, any of the tertiary phenomena which appear in acquired syphilis may develop, but, in addition to these, peculiar manifestations may be produced, especially affecting the teeth, bones, and cornea

The **Teeth** in inherited syphilis are sometimes very characteristic. The temporary teeth usually appear early, are discoloured, and crumble away. The permanent teeth are often sound and healthy, but are sometimes deformed. The central incisors of the upper jaw are those most particularly affected, but the upper laterals and the incisors of the lower jaw may also be involved. Instead of being broader at the crown than at the root, they diminish in size from

root to crown, being stunted, and separated from one another by interspaces. The angles of the crown are rounded off, and a distinct notch, forming a large segment of a small circle, occupies the centre. The enamel is often imperfectly developed, and hence they decay early. Occasionally they may be shaped like a screw-driver, narrowing from root to crown, and with a straight free border. The notched and stunted teeth described above are sometimes known as 'Hutchinson's teeth,' but they are not very commonly seen at the present day.

The **Bone** affections observed in inherited syphilis will be described at Chapter XX.

**Interstitial Keratitis**, or diffuse inflammation of the cornea, usually occurs about the age of puberty, or earlier. It is limited at first to one eye, but the other is almost certain to be similarly affected at a later date. It commences as a diffuse haziness of the cornea, which looks something like ground glass, associated with hyperæmia of the ciliary region. Red areas, or 'salmon patches,' may be produced in the midst of the opacity, due to a new formation of minute vessels. There is no tendency to ulceration, but in protracted cases the anterior part of the eye may bulge forwards, constituting a condition known as 'anterior staphyloma.' The inflammation may spread to the iris and ciliary body. With suitable precautions the cases usually do well, although treatment for several years may be necessary.

The **Treatment** of inherited syphilis should commence as soon as definite manifestations of the disease are present. The general health must be attended to, and if the mother is unable to nurse the child, it must be brought up by hand, on no account must it be given to a wet-nurse. Mercury is best administered by anointing the under surface of the flannel belly-band with mercurial ointment, or the same preparation may be rubbed into the soles of the feet every night. This should be continued until all secondary phenomena have disappeared, and advisably until the child is a year old. Cod-liver-oil may also be ordered with advantage in some cases. When tertiary symptoms appear, iodide of potassium and mercury may be given in a mixture, in suitable doses.

The local treatment of external lesions is conducted according to the rules laid down for the acquired type of the disease.

## Tuberculosis

By tuberculosis is meant a condition resulting from the development within the tissues of the body of certain definite anatomical structures, known as tubercles, and caused by the growth and activity of the *Bacillus tuberculosis*. Before the fact was established that such lesions were due to a micro-organism, they were usually termed strumous or scrofulous, and even at the present day these two names are occasionally employed to indicate that condition of constitutional weakness which predisposes to the appearance of



tuberculous disease It is better, however, to avoid the use of such misleading terms

**Ætiology** —1 The *individual* is often predisposed to the development of this disease by some inherited weakness, as indicated by the fact that parents, relations, or ancestors have suffered from some similar affection, or that it has occurred in other branches of the same family It is becoming doubtful, however, whether heredity plays such an important part as was formerly attributed to it, and whether the disease is not much more commonly due to direct infection Considerable ingenuity has been exercised in describing various types of physiognomy supposed to be characteristic of a tuberculous inheritance, and although not always present, these appearances are not unfrequently observed Two chief varieties are described, viz, the *sanguine* and the *phlegmatic* In the former, the individual is slight and well proportioned, possessing a thin, delicate

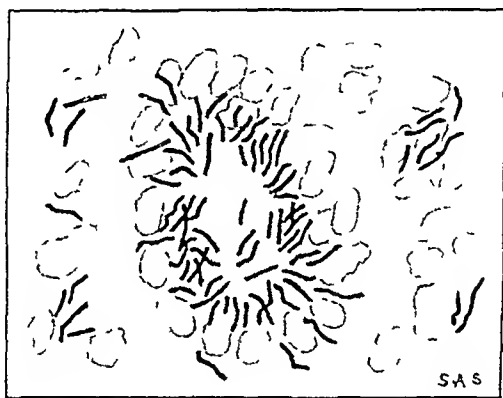


FIG 23 —BAC TUBERCULOSIS IN AND AROUND GIANT CELL (CROOKSHANK'S 'TEXTBOOK OF BACTERIOLOGY')

skin, often freckled, and so transparent that the subcutaneous veins are readily seen The hair is fine and auburn-coloured, or even reddish, the conjunctivæ are thin and pearly, the eyelashes well developed, and the fingers long and tapering Such children are usually excitable and precocious in their habits, and possess taking manners The phlegmatic type is characterized by a short, stunted stature, with somewhat coarse features, and strong though somewhat short limbs The skin is coarse and muddy-looking, the lips thick, the hair rough and brown In children of either type there is a considerable tendency to the development of eczema, inflammation of the mucous membranes, and a subacute enlargement of the lymphatic glands, all of which are simple in nature, but may constitute a suitable nidus for the development of tubercle, especially if the child is run down by some preceding illness, such as measles or scarlet fever They also suffer frequently from cracked lips, and as a result of the irritation caused thereby considerable infiltration and thickening may follow Although tuberculous disease is most

frequently seen in young people or children, no age is exempt from its attacks, even elderly persons being affected by what is known as 'senile tuberculosis'. These senile manifestations differ in no way from those met with in the young.

2 *Unhealthy surroundings and bad hygiene* certainly predispose to its development, hence it is seen, perhaps, in its severest forms amongst the poor, although it is only too common amongst the rich, arising usually from improper feeding and want of fresh air in the case of children, and not unfrequently from faulty hygiene or carelessness, especially as to judicious clothing, in adults.

3 A *local nidus* suitable for the development of the micro-organism usually exists, although tuberculous infection occasionally follows wounds and punctures in previously healthy parts. Thus, as already mentioned, chronically inflamed lymphatic glands form a suitable breeding-ground for the bacillus, as also bones and joints in a state of congestion resulting from slight and often overlooked injuries.

4 The ultimate exciting cause of tuberculosis is the development within the tissues of the *B. tuberculosis* of Koch (Fig 23). It usually occurs in the form of slender rods, which are straight or slightly curved. They are usually about 4 or 5  $\mu$  in length and 0.2 or 0.3  $\mu$  wide, but sometimes they form long *branched* filaments, especially in cultures. These characters differentiate them strongly from most bacilli, and have led to the opinion that the organism is in reality allied to the streptothrices, and the names *tuberculomyces* and *streptothrix tuberculosis* have been given to it. This is interesting in view of the close clinical resemblance between tuberculosis and the other diseases due to streptothricial infections (the so-called actinomycosis). The tubercle bacillus is a typical acid-fast organism, and when stained by Ziehl-Nielsen's method appears in the form of slender pink rods, which are often stained only in part, so that they seem to consist of short red lengths alternating with unstained areas, the whole looking not unlike a chain of very minute streptococci (Plate I, Fig 5). *In vitro* they develop very slowly, two or three weeks elapsing before growth is visible, and require a temperature approaching that of the body and an abundant supply of oxygen. Many culture media are available, and all are improved by the addition of 3 or 4 per cent of glycerine. The colonies consist of yellowish, white, or gray scales, which have usually a dryish look and spread slowly. The tubercle bacillus does not liquefy blood serum, it is non-motile, has no flagella, and is not known to possess spores.

The question of the identity of human and bovine tuberculosis has been recently raised by Koch, who maintains that the two organisms are distinct, and that the bovine bacillus does not cause tuberculosis in human beings, or at any rate but rarely, if this is the case, the danger from the ingestion of tuberculous milk or meat is negligible. The problem is still under discussion, but at present the evidence points decidedly against Koch's view, and it is advisable to disregard it in practice.

The organism gains access to the body in one or other of the following ways

(a) Most commonly by *inhalation* Tubercle bacilli are present in vast numbers in the sputum of consumptives, and, as drying does not immediately kill them, they frequently occur in the dust and in the air. More important still is the fact that in coughing and talking the tuberculous material is expelled in a state of very fine division, and the infective particles remain suspended in the air for long periods. Tuberculosis acquired by inhalation usually manifests itself in the form of pulmonary disease, but may appear as a primary affection of the bronchial glands, from which the infection may be disseminated to other organs. The bacilli may also lodge on or in the crypts of the tonsils, and cause tuberculosis of the glands in the neck, but this probably occurs more often when the infection is carried by the food.

(b) By *ingestion*. This is comparatively rare, and usually manifests itself in primary tuberculosis of the intestines or abdominal lymph glands. It should be remembered that these lesions may also be caused by swallowing tuberculous sputum.

(c) By *inoculation*. This is very unusual, and occurs chiefly in pathologists, post-mortem room porters, etc., in the form of a verruca necrogenica (p. 243). A few cases of tuberculous infection from an accidental cut inflicted by a broken sputum cup have been recorded.

(d) A few cases of *congenital* tuberculosis may possibly be caused by the presence of tubercle bacilli in the ovum or spermatozoon, but this is almost incapable of proof.

The *pathological diagnosis* of tuberculosis is conducted on one or other of the following lines

1 By the microscopic identification of the tubercle bacillus, *e.g.*, in the sputum. Films are stained by the Ziehl-Nielsen method, and searched for the characteristic rods. This is sufficient when bacilli are present in large numbers, but when this is not the case (as frequently happens in the urine, pus, pleuritic fluids, etc.) it is necessary to have recourse to—

2 Inoculation of susceptible animals, especially guinea-pigs, which is a most delicate test. The material is usually inserted beneath the skin of the groin, and the animal killed in three weeks, when the lymph glands and probably the internal organs will be found tuberculous.

3 Tuberculous exudates differ from most others in that the cell which occurs most abundantly is the *lymphocyte*, and this fact is made use of in the examination of pleuritic and peritoneal exudates, the fluid obtained by lumbar puncture of the spinal meninges, etc. It is useful, but must not be regarded as an absolute test.

4 In some cases a portion of the lesion may be excised and submitted to microscopic examination, which should include a search for bacilli, since other infections may give rise to lesions indistinguishable microscopically from tuberculosis. It is still better to inoculate a portion of the tissue into a guinea-pig.

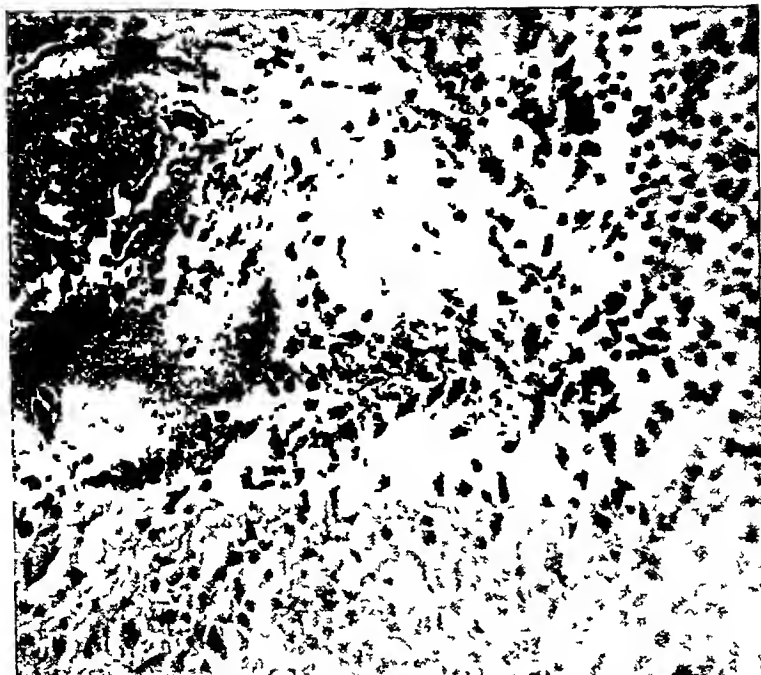


FIG 24 —MILIARY TUBERCLE WITH GIANT CELL (HIGHLY MAGNIFIED)

In the giant cell on the left are a large number of nuclei arranged around the periphery, and from it processes can be seen extending into the surrounding epithelioid zone whilst beyond this, especially on the right side, the invasion with round cells (? lymphocytes) is evident

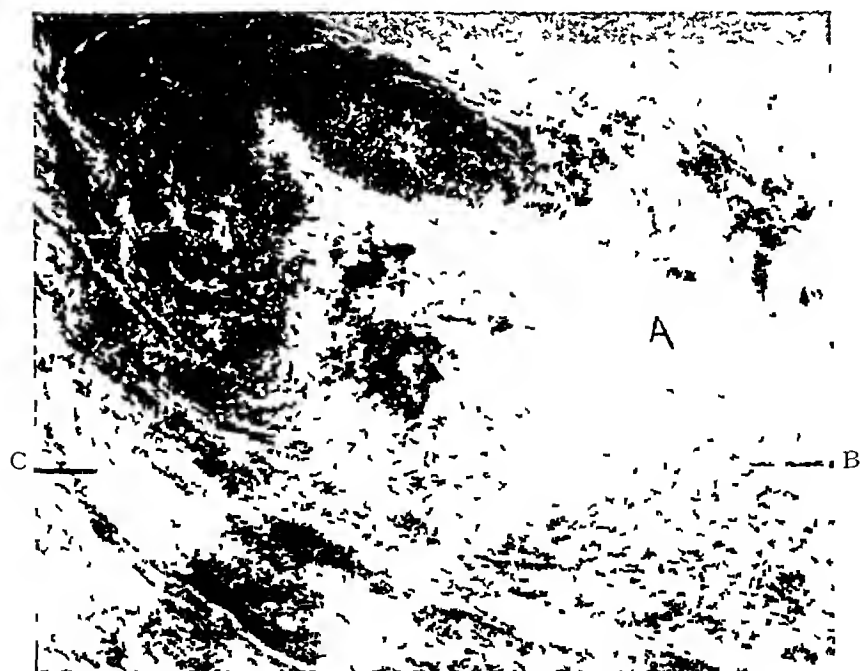


FIG 25 —TUBERCULOUS ABSCESS FROM A SUPPURATING LYMPHATIC GLAND (LOW POWER)

A, abscess cavity lined by necrotic granulation tissue in which are seen here and there, B, giant cells C fibro-cicatricial zone outside the granulations



5 *Tuberculin* is a solution of the substances given off by the tubercle bacillus when grown in glycerine broth. When injected into a normal person it produces no effect, but in tuberculous patients a sharp rise of temperature occurs in a few hours. The test is not altogether devoid of danger, and should never be used unless one is certain of the absence of a secondary infection, e.g., with streptococci.

**Pathological Anatomy**—The characteristic lesion is the *miliary tubercle*, a cellular mass 2 or 3 millimetres in diameter, and when isolated, readily visible to the naked eye. When young and in course of active evolution, tubercles are soft, translucent, and of a gray colour; after a time they undergo fatty degeneration and become yellowish and opaque. It is often impossible to recognise them macroscopically, since when closely set they tend to fuse together, but when the mass thus produced is submitted to microscopic examination, the individual tubercles can always be distinguished.

The *minute structure* can be best understood by the examination of a typical fully-formed tubercle which has not begun to undergo retrogressive changes, and this is most readily observed in sections from the meninges in tuberculous meningitis, or from the liver or kidney in a case of general tuberculosis. In the centre of the mass there is a giant cell (Figs 23, 24), the diameter of which may be many times that of a red blood corpuscle. It has usually an oval or circular shape, and its outline is regular; it has many oval nuclei, and these are arranged round the periphery of the cell, their long axis lying in a radial direction. Around the giant cell there is a zone of epithelioid or endothelioid cells. These are usually oval in shape, and rather larger than a leucocyte. Each has a single nucleus, which has a close resemblance to one of the nuclei of the giant cell. Around this zone there comes the third, or outer one, which is composed of small round inflammatory cells, which appear to be identical with lymphocytes. It must be understood that all tubercles do not conform exactly to this typical description. The giant cell, for example, is frequently missing, especially in acute cases, or there may be several cells of this type, though this is unusual. Then the width of the zones varies greatly, in some cases the endothelioid cells may appear to be absent, but can be detected mixed up with the lymphocytes, which extend to the centre of the tubercle.

It must be clearly understood that a 'tubercle' in the histological sense is not peculiar to tuberculosis, in the sense of a disease due to the tubercle bacillus. It is simply the reaction of the tissues to an irritant of comparatively feeble activity. Thus it occurs in actinomycosis (see Fig 29, where a typical histological tubercle is shown surrounding a colony of actinomyces) and may be produced by an unabsorbed ligature, irritants, such as grains of pepper, etc. Hence it is not always safe to make a diagnosis of tuberculosis from an examination of sections, unless the characteristic bacilli are demonstrated.

The *development* of a tubercle is not yet fully understood. The bacilli appear to gain access to a lymph space or to a small vessel, where they set up an overgrowth of the endothelial elements, and, as always happens when they become inflamed, the endothelial cells become oval or spherical, and of large size, these constitute the epithelioid cells of the middle zone. The giant cells\* appear to be composed of a mass of these cells, in which the nuclei have undergone repeated divisions, but the protoplasm has remained unsegmented. The source of the lymphocytes, and whether they are produced locally or attracted from the blood-stream, has been hotly debated. It appears on the whole most probable that they are formed locally, possibly by a process of budding from the endothelial cells.

Miliary tubercles may be embedded in practically normal tissues, but in most cases the inflammatory process can be traced beyond the nodules. The affection of the surrounding parts varies. In mild cases there is a chronic inflammatory process, with an increased formation of fibrous tissue, whilst in the more active forms the intervening structures disappear, being infiltrated and replaced by granulation tissue, which is often œdematous and of a gelatinous appearance. This latter is especially frequent in tuberculosis of the bones and joints. The effect of the inflammation of the surrounding parts is especially marked in the smaller vessels, and chiefly in the arterioles, the lumina of which may become greatly narrowed, or even entirely obliterated, by a process of endarteritis. In this condition the vessel wall becomes infiltrated with leucocytes, which collect in the subendothelial layer. They become mixed with fibroblasts, the origin of which is uncertain, and the cellular mass gradually undergoes organization, layers of fibrous tissue, concentric with the original coats of the artery, being produced. The vessels may also be affected by the production of true tubercles in their walls, but this is much rarer. In either case the vascular affection diminishes the blood-supply of the tuberculous mass (which is already defective owing to the fact that no new vessels are formed in the tubercles), and increases the likelihood of caseation.

A fully-formed tubercle may undergo *evolution* along one of the following lines, according to the virulence of the bacilli and the resisting powers of the patient.

1. When the bacilli are but slightly virulent and the patient's susceptibility moderate, the tubercle undergoes *fibrosis*: this is the natural method of cure. In a fibrosing tubercle the endothelioid

\* It may be well to notice here that three forms of giant cells occur pathologically, and are of very different significance. (1) Those described above (the tuberculous type), having their nuclei arranged around the periphery of the cell. (2) Myeloplaxes which occur in myeloid sarcomata, and have many nuclei grouped irregularly round the centre of the cell. (3) Parenchymatous giant cells occurring in the substance of tumours, especially sarcomata and carcinomata. These have usually a single nucleus or at most a few, which may be of large size and have no definite arrangement.

cells become spindle-shaped, their nuclei elongated, and the cells are converted into fibroblasts. A similar change takes place in the giant cell, the periphery of which becomes drawn out into delicate ramifying processes which penetrate amongst the endothelioid cells, and join with them in forming fibrous tissue. The lymphocytes become less numerous, and ultimately the tubercle is represented by an ill-defined nodule of new fibrous tissue.

2 When contrary conditions exist, the bacilli being virulent and the patient in a non-resistant condition, **caseation** occurs. This is a process of fatty degeneration of the nodule, especially of the central portions, followed by necrosis of the degenerated area. The result is the formation of a uniform structureless mass in the centre of the tubercle, it may be readily recognised in ordinary sections from the absence of all definite cells or tissue elements, and the fact that it stains with acid dyes, such as eosin. It is not often possible to demonstrate bacilli in this cheesy mass, they are there, however, as inoculation experiments show. This process of caseation occurs in lesions other than tuberculosis, and is due to the action of the toxins on the tissues, it is especially common in this disease, since no vessels penetrate the tubercles, which are in consequence badly nourished.

Cure may take place at this stage by a process of fibrosis of the surrounding parts, so that the caseous mass becomes walled in by a zone of fibrous tissue. When this happens the cheesy material gradually dries up, and may become calcified. When this latter phenomenon happens cure is probably complete, but living bacilli may occur even in dried-up caseous substance, and under suitable conditions recrudescence may occur, even after an interval of years.

3 In most cases in which caseation occurs the process continues to spread. New tubercles are formed on the outskirts of the necrotic area, and these in their turn caseate, in this way cheesy masses of considerable size may be produced. In some cases an exudation of fluid takes place into this mass, and the result is a **tuberculous abscess**, which is the commonest form of 'chronic' abscess. Wherever tubercle can be deposited, a chronic abscess may form, but it occurs most commonly in connection with bones, joints, and lymphatic glands.

The *pus* from such an abscess consists of disintegrated fatty material mixed with a variable quantity of fluid, so that it is sometimes thin and milky, sometimes so thick that it will scarcely flow through a cannula. It often contains masses or flakes of curdy debris, and on microscopic examination a few lymphocytes may be found. Tubercle bacilli may be found without much difficulty in the more active cases, but in chronic forms they are often few and far between, or possibly cannot be demonstrated, though inoculation experiments show that they are present. In old-standing cases an abundance of cholesterol crystals may be seen, a fact recognised by the naked eye by the glistening sheen or greasy appearance im-



parted to the pus, microscopically, they appear as flat rhomboidal plates with one corner notched out

Abscesses may also form in a tuberculous nodule as a result of secondary infection with pyogenic bacteria. This is an entirely different process, and one that is usually much more serious for the patient. The pus in this case may not differ appreciably from the ordinary pus of acute abscesses, and the fact that it contains tubercle bacilli may only be demonstrable by inoculation.

The *microscopic appearance* of a tuberculous *abscess wall* is quite characteristic (Fig 25). The cavity is lined by a layer of gray, yellowish-gray, or pinkish, pulpy granulation tissue, containing miliary tubercles, perhaps undergoing caseation. Its colour and vitality are dependent upon the chronicity or not of the process, the longer the abscess is in forming, the less vascular the membrane, owing to the associated sclerosis of the surrounding structures leading to compression of the bloodvessels, whilst it has been already mentioned that endarteritis always accompanies a chronic inflammation, and helps to render the parts non-vascular. This lining membrane, when necrotic, is but loosely connected with a layer of fibro-cicatricial material, which forms the outer part of the wall, and from which it can be readily detached by the finger or a sharp spoon. This, in turn, gradually shelves off into the normal tissue which surrounds the abscess.

A chronic abscess forms a soft fluctuating swelling which gradually increases in size, and may become painful by exerting pressure on a nerve or other sensitive structure. Should it be *superficial*, it will probably come to the surface and burst, the pus and caseous detritus will be discharged, and possibly, if the general health is good, the wound may slowly granulate and heal, but more commonly the tuberculous tissue left behind prevents healing, and a *tuberculous ulcer* develops. A similar condition is found in connection with mucous membranes, the tuberculous foci starting in the submucosa, and subsequently bursting through the mucous membrane (Fig 26). Whatever their location, the ulcers are characterized by the same features, viz., an irregular and ragged margin with undermined and congested edges, the base is formed by pulpy granulation tissue containing caseous masses of tubercle ( $\tau_1$ ), which usually must be removed by scraping before healing can occur.

On the other hand, if the abscess is of *deep* origin, it has a great tendency to burrow along fascial planes, and hence to become superficial at a distance from its original source. This is especially the case in tuberculous disease of the spine, in which the pus may travel far afield, e.g., in a psoas abscess. The far-reaching extent of these abscesses, the impossibility of dealing adequately with the lining membrane, together with the infective nature of the disease and the often inaccessible position of the original focus of the mischief, render them most difficult to treat, and fully account for the dread of opening them experienced by surgeons in pre-antiseptic days, for should the cavity of the abscess once become septic, there is but little hope



probably through dissemination by the bloodvessels. Thus phthisis is a not uncommon sequence of a similar affection of bones, joints, or lymphatic glands, whilst meningeal tuberculosis is more frequently associated with tuberculous affections of the genital organs. (c) Moreover, any tuberculous lesion may lead to *acute general tuberculosis*, in which the disease is scattered widely throughout the body, giving rise to rapid emaciation, high fever of an intermittent type, and usually severe diarrhoea, dyspnoea, and delirium or coma, death ensuing in a few weeks.

**Treatment**—It must be fully recognised that tuberculosis is an infectious, and therefore, to a large extent, a preventable disease, and it is the duty of all medical practitioners to do everything in their power to limit its ravages. We cannot here enter into this subject, but would merely mention the dangers to the general public arising from the distribution of milk obtained from tuberculous cows, and from the indiscriminate expectoration of tuberculous sputum.

Curative treatment is based on the assumption that natural processes of repair have a considerable influence upon the course of the disease. When Koch first discovered the bacillus, a great impetus was given to surgical treatment, and some authorities went so far as to maintain that it was as necessary to extirpate every particle of diseased tissue as in a case of cancer. The pendulum has now slowly swung back, and we are more and more endeavouring to promote healthy repair of the lesions by constitutional measures. The value of an abundance of fresh air is fully admitted, and many sanatoria for the open-air treatment of phthisis and other tuberculous lesions are now in existence. For surgical cases residence by the seaside, especially in such bracing places as Margate, or, if that be too cold, Ramsgate, Bournemouth, or Ventnor, is usually recommended. At the same time, plenty of good food, such as milk and eggs, must be taken. Local foci should be kept at rest, and if the disease is external, elevation and steady pressure (as by Scott's dressing) are desirable accessories. On the other hand, if a tuberculous lesion is sufficiently localized and suitably situated, as when it occurs in the lymphatic glands of the neck, total excision is the ideal treatment, although one has sometimes to be satisfied with scraping. In this process the possibility of disseminating the disease by too vigorous manipulations must not be overlooked. Any open tuberculous sores should be well scraped, overhanging and undermined portions of skin cut away, and the surface then swabbed over with liquefied carbolic acid, and dressed with gauze soaked in an iodoform emulsion.

The manifestations of tubercle as it affects special organs are dealt with elsewhere under the appropriate headings (see diseases of skin, bones, joints, lymphatic glands, kidney, testis, etc.)

**Treatment of Chronic Tuberculous Abscess**—The conditions under which chronic abscess presents and upon which it is dependent are so diverse that the treatment must necessarily vary considerably in

different cases. A superficial chronic abscess is comparatively easy to treat, but one placed deeply, and connected with such an affection as tuberculous disease of the spine, must be approached with caution, and seeing that one slip in the technique might lead to a fatal issue, no one should undertake to deal with these cases unless they are fully competent to maintain asepsis. That it is desirable to evacuate the abscess cavity in the vast majority of cases is obvious, although under specially favourable circumstances one might leave the condition to be dealt with by Nature, this, however, would involve the risk of an acute disturbance, due to a possible pyogenic infection, whilst it would also entail subsequent dangers owing to the encapsulation of tuberculous material within the body. Hence the ideal treatment always consists of removal of all tuberculous tissue and evacuation of abscesses. The following plans may be adopted.

1 In certain cases of external chronic abscess, especially when connected with lymphatic glands, it may be possible to dissect out the whole cavity en masse, and if such is feasible, it is the most satisfactory plan to adopt. Should the posterior wall of the cavity be adherent to important deep structures, it should be thoroughly scraped so as to remove all pyogenic material, and disinfected, e.g., with liquefied carbolic acid or solution of zinc chloride (40 grains to 1 ounce). An attempt may then be made to gain healing by first intention, or the cavity may be stuffed and allowed to granulate.

2 When the skin is thin and undermined, and the abscess nearly pointing, it is hopeless to avoid leaving an open wound, and hence the condition must be treated in the same way as many a case of superficial abscess which cannot be dissected out—viz., the cavity is laid freely open, all healthy skin is excised, and the cavity, if not too large or deep, is treated with pure carbolic acid or chloride of zinc (gr. xl ad ʒ i), packed with gauze infiltrated with iodoform, and allowed to heal from the bottom. In deep collections of this type—e.g., a psoas abscess—a tube may be introduced for a time, and subsequently the cavity packed as far as possible. Every care must be taken to avoid retention of discharge and to prevent sepsis. At the same time the patient must be placed in the best hygienic conditions possible, and in this way it may be possible to bring about a cure, but we would urge on practitioners the fact that a psoas abscess ought never to be allowed to reach a condition in which it is necessary to leave an open wound on account of the abscess pointing.

3 When a chronic abscess is situated deeply and covered with healthy tissues, treatment consists in emptying the cavity of its contents, removing as far as possible the tuberculous lining membrane, and closing up the wound after introducing into the cavity some modifying or antiseptic injection.

In many cases tapping with trocar and cannula suffices for this purpose. The *modus operandi* is as follows. The skin over the abscess is incised, and a large trocar and cannula introduced so as to allow the contents to escape. The cavity is then washed out with sterilized salt solution (ʒ i ad O i) at a temperature of 105° to 110° F., and the abscess well kneaded from the outside so as to detach curdy material and necrotic pyogenic membrane. This is continued until the escaping fluid is nearly clear or only slightly opalescent. A varying quantity of an emulsion of cod liver oil or glycerine (10 per cent) is then introduced, and the opening closed. In this way it is often possible to cure a chronic abscess without sitting. The treatment is most likely to be efficacious when all active bone or joint disease has disappeared, and residual abscesses are perhaps the most favourable of all.

Where the disease is more active, it is often wiser to make an incision into the abscess sufficiently large to introduce the finger. Through this opening diseased bone can possibly be removed and the lining wall scraped and for

this purpose a *Baiker's* flushing-gauge is often useful. The instrument consists of a gauge or sharp spoon with a long hollow handle, which communicates by a tube with a reservoir of fluid placed at some height above the patient. During its application the constant rush of water or lotion through the handle clears the gauge and removes the debris. It is admirably adapted for certain cases, but its use needs considerable care, as the sharp edge can readily scrape through an abscess wall, and do much mischief. The wounds should be subsequently closed after injecting the iodoform emulsion, and an attempt made to gain immediate healing of the denuded cavity by bringing the sides into apposition by suitable pressure.

Not uncommonly the cavity refills with fluid in the course of three or four weeks, and the irrigation may then have to be repeated. The fluid withdrawn on this occasion is often blood-stained serum, perhaps smelling strongly of iodoform. It is possible that in such cases a sinus develops sooner or later, and has to be dealt with by simple drainage, or, when the discharge is but slight, by picking. The convalescence under these circumstances is always very prolonged, and if sepsis is to be avoided, great care will have to be exercised in dressing the case.

The employment of iodoform in these cases is largely due to Professor *Velpeau*. It may be suspended in glycerine or olive-oil (10 per cent) or dissolved in ether (5 per cent), but as a rule not more than a drachm of iodoform should be injected. When the ethereal solution is employed, the ether immediately volatilizes and fully distends the abscess cavity, which becomes tense and tympanitic, it must therefore never be used for abscesses communicating with the interior of the thorax, death having in one or two recorded cases resulted from heart failure, due to such distension. There is some danger, too, that serious toxic symptoms may arise from absorption of the iodoform.

## Glanders

Glanders is primarily a disease of the horse, ass, or mule, which is transmitted to men by direct inoculation, and hence is usually seen only in stable attendants and those brought in contact with such animals. It is characterized by the development of inflammatory swellings under the mucous membrane of the respiratory tract, which break down and ulcerate, and by the formation of similar growths, embolic in origin, in the lungs and other viscera, which go on to abscess formation.

There is now no doubt that the disease is due to a definite micro-organism, the *Bacillus mallei*, which was isolated about 1882 by *Schutz* and *Löffler*, and has since been cultivated outside the body, the experimental evidence as to its being the cause of the malady is quite complete.

In *Horses* and other animals, glanders manifests itself by a formation of larger or smaller rounded swellings in the mucous membrane of the nose, which break down and ulcerate, giving rise to a thin, sero-purulent discharge, and perhaps to destruction of the bones and cartilages. The lymphatic glands, especially those under the jaw, early become enlarged, constituting the 'farcy buds' of farmers, and by their ulceration may leave ragged, foul sores. The lymphatic trunks to and from the glands are involved ('corded veins'), whilst the lungs and internal viscera may also be infected, and undergo destructive changes, usually ending in suppuration. The disease is often chronic, lasting perhaps for years, any undue strain put upon the animal may lead to an acute outbreak, which is fatal in six to twelve days.

In *Man*, glanders generally starts about the hands and face, but occasionally in the nasal mucous membrane. In *acute* cases the incubation period lasts from three to five days, and is succeeded by the occurrence of malaise and febrile disturbance, followed by severe pains in the bones and joints. The site of inoculation becomes swollen and angry, whilst the lymphatics leading from this to the nearest glands are enlarged and inflamed. An eruption of papules, which somewhat resemble those of small-pox, occurs around the primary lesion, on the

face, and in other parts of the body, but each papule, as also the primary lesion, breaks down and goes on to the formation of an ecthymatous-looking ulcer. It is not an uncommon feature of these sores, when placed over a bony surface, to involve the periosteum and lay bare the subjacent bone. Similar changes occur in the viscera, muscles, and joints, and these being associated with high fever of an asthenic type, may suggest the existence of pyæmia. In such cases death may ensue in seven to ten days.

In **Chronic Glanders** similar symptoms are met with, but the course is slower, there is little or no fever, the disease is less extensive, and intermissions are not uncommon. Total recovery is stated to occur in 50 per cent of the cases. It may affect the nasal mucosa, leading to chronic ulceration, but more commonly it appears in the shape of chronic abscesses, which often extend deeply, even down to the bones, and are very difficult to deal with. In one case the disease gradually spread down along the peroneal muscles, and in spite of repeated scrapings and the application of pure carbolic acid, the process was only arrested at the point where the peroneus longus disappears into the foot.

It is important to determine the **Diagnosis** as early as possible, in order to undertake energetic local treatment. The local lesions are distinguished from small-pox by the presence of the characteristic bacilli in the discharge, by the fact that they more extensively involve the subcutaneous tissues, and by the absence of umbilication. Chronic cases resemble *syphilis* and *tuberculosis* but the history of exposure to infection from animals suffering from the disease is most important, as also the result of cultivations made from the discharge. When the bacilli are grown on potatoes, a colony of a yellowish, honey-like character forms in two or three days, which gradually turns to a chocolate-brown colour. Inoculation of the peritoneal cavity of a guinea-pig with some of the secretion leads to acute orchitis in two or three days, the testicles being enlarged and the skin over them reddened, the infection usually runs on to suppuration. Mallein, a sterilized culture of the organisms, may also be used for diagnostic purposes, an injection of a minute dose causing a sharp febrile reaction if glanders is present.

**Treatment** in acute cases can be of use only when undertaken early, and before general infection has ensued. The local foci should be thoroughly extirpated, either by the knife, or by scraping and applying some active cauterizing agent. The same treatment must be adopted in chronic cases, and may then need frequent repetition.

## Leprosy

Leprosy (*syn. lepra*, or *elephantiasis Græcorum*) is a general infective disease due to the *Bacillus lepra*, characterized by the formation of granulation-like neoplasms, which arise primarily in connection with the skin and nerves.

The bacillus of leprosy closely resembles that of tuberculosis, and, like it, is strongly acid-fast, staining by Ziehl-Nielsen's method. The two organisms are difficult to distinguish, but the leprosy bacilli are usually straighter and more uniform than those of tubercle, and when seen in sections of leprous material they are often present in far larger numbers than are the tubercle bacilli in tuberculous tissues. They are usually packed together like bundles of cigarettes (Fig 27). Numerous attempts have been made to cultivate them, and a few observers claim to have succeeded, but their results have not been generally

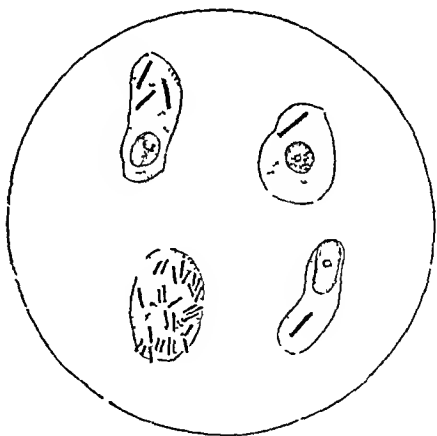


FIG 27 —LEPROSY BACILLI CONTAINED WITHIN EPITHELIAL CELLS

accepted All attempts to inoculate animals with the disease have failed, and inoculation constitutes the best and most definite test between the two diseases

Leprosy, though formerly common in this country, is now only met with in imported cases In Iceland, Norway, Russia, and the East, it is still frequently met with, although the method of segregation of lepers enforced in Norway has greatly diminished the number in that country It is apparently very slightly contagious The medical attendants and nurses in leper hospitals rarely contract



FIG 28 —LEPROSY (FROM A PHOTOGRAPH KINDLY LENT BY W THLLWALL THOMAS, ESQ , OF LIVERPOOL )

The patient had lived as a sailor, and contracted leprosy abroad many years before The facial aspect is very characteristic, and the forearms are enlarged owing to leprous deposits in the subcutaneous nerves

the disease, and inoculation experiments in criminals have led to negative results Mr Jonathan Hutchinson has argued that infection only takes place in persons who eat badly cured or partially decomposing fish Opinions differ as to whether the disease is transmitted to the descendants, but probably this is not the case

**Symptoms** —Two chief varieties of leprosy exist viz , the tuberculated and the anæsthetic or non tuberculated but the two are often associated

**Tuberculated or Cutaneous Leprosy** is the form most commonly seen in Europe Nothing may be noticed for months or years after exposure to the contagion, and then, after a period of malaise, associated with dyspepsia, diarrhœa, and

drowsiness a distinct febrile attack is noted, lasting for days or weeks it may be ushered in by a rigor, and the temperature is usually of a remittent type. This is followed by or associated with the appearance of shiny red hyperæmic spots which are from the first infiltrated slightly raised, and hypertrophic they are usually situated on the forehead or cheeks on the outer side of the thighs or on the front of the forearms. They may fade a bit and disappear entirely and then again become evident, or fresh patches may be developed and always with febrile symptoms. After a variable period tuberculation ensues numbers of little pink nodules form over the site of one or more of the erythematous patches and these gradually increase in size and coalesce, until possibly they become as large as a walnut or hen's egg, and are then of a brownish yellow colour. Almost any part of the surface of the body may be involved in this manner but the face is especially prone to be involved, and the resulting disfigurement is very marked a curious leonine appearance being imparted to the features (Fig. 28). The nodules are more or less anæsthetic from the pressure of the infiltration on the nerves, and the ultimate result of the process may vary considerably resolution sometimes occurs or the nodules may be transformed into depressed and pigmented cicatrices or ulceration may ensue. Visceral complications and enlargement of the lymphatic glands follow any fresh deposit being associated with febrile phenomena. The testes atrophy, and sexual power is lost in both sexes. Death is usually due to septic phenomena, laryngeal obstruction or disease of the lungs or kidneys but the patient may live for many years.

The nodules consist of masses of granulation tissue, and scattered through them are numbers of large cells containing multitudes of bacilli (Fig. 27).

Anæsthetic, or Non tuberculated, Leprosy is the most common form met with in hot climates. The earliest phenomena consist in a certain amount of malaise without appreciable fever, together with sharp tingling or lancinating pains and tenderness along the course of certain peripheral nerves. The ulnar median peroneal, and saphenous nerves are those most often affected. This is followed by muscular weakness running on finally to paralysis various modifications of sensation, and trophic phenomena involving at first only the skin, but later on attacking bones joints and muscles. Circular yellowish white patches are observed in the skin spreading peripherally and tending to run together forming large irregular ovals the border is often raised and hypersensitive but the central portions become atrophic dry white and anæsthetic. The anæsthesia gradually spreads, and serious lesions, partly due to trauma, partly arising from trophic changes result. The muscles atrophy and contract, and give rise to deformity, the hands sometimes becoming markedly clawed as in ulnar paralysis. Interstitial absorption of the bones of the peripheral portions of the limbs may lead the fingers toes and other portions to shrivel and disappear preceded by ankylosis of the joints. The affected nerves can usually be felt distinctly enlarged and tender. Visceral lesions are not so marked in this as in the other form of the disease and the patient may retain a considerable degree of health and strength, whilst his sexual powers are not much interfered with. Finally he dies from general debility, or from various complications, but the case may last twenty or more years.

The Treatment is still very unsatisfactory. Chaulmoogra oil administered both internally and externally is the drug most frequently depended on, but latterly intramuscular injections of corrosive sublimate have been employed with some success.

### Actinomycosis

Actinomycosis is a disease of cattle and is due to infection by a streptothrix called *Actinomyces* (the ray fungus). A similar disease occurs in man but is rarely, if ever, caused by the same organism the term actinomycosis is therefore hardly suitable but is, we fear too firmly rooted to be displaced.

Actinomycosis in cattle is usually acquired by eating infected barley or other cereal fragments of which are sometimes found in the primary lesion. It most commonly affects the tongue or jaw, and causes a chronic fibrotic inflammation



(the wooden tongue, big jaw, or 'osteosarcoma' of cattle) These often suppurate in many places, producing multiple chronic abscesses, which discharge externally and leave a diffuse inflammatory mass riddled with sinuses. The pus from such

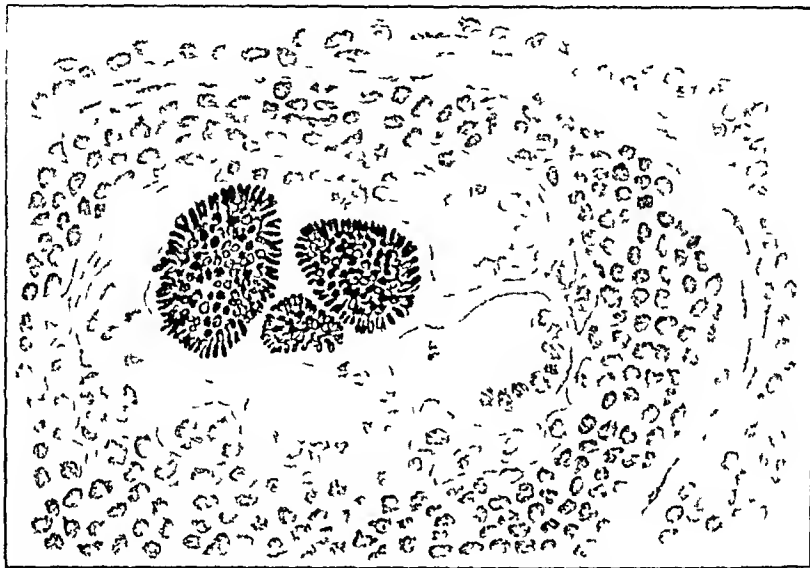


FIG 29 —BOVINE ACTINOMYCES IN TONGUE (FROM CROOKSHANK'S 'TEXTBOOK OF BACTERIOLOGY')

abscesses contains small yellow or brown gritty bodies (often looking like grains of iodoform) which consist of colonies of the fungi, perhaps undergoing calcareous changes. The structure of these colonies

may be made out by crushing the particles between two slides and staining the films thus produced, but is better seen by an examination of sections. Each colony consists of a tangled mass of mycelium, the central portion of which often shows the presence of 'chain spores,' whilst the peripheral part has a definite radial arrangement, from which the organism derives its name. The mycelial filaments which project from the outer portion of the colony are often greatly thickened and appear in the form of Indian clubs, the narrow ends being pointed inwards. These 'clubs' were formerly thought to be reproductive organs, but are probably caused by a degeneration of the sheaths of the filaments. They are very well seen in bovine actinomycosis (Fig 29), but are often absent or very badly formed in man.

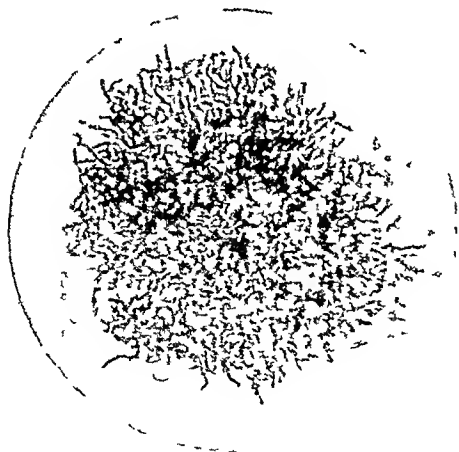


FIG 30 —COLONY OF HUMAN ACTINOMYCES, AS SEEN IN PUS

The absence of the radially-arranged 'clubs' is very obvious

In Man the disease is very similar in its clinical character, and may be caused by a number of organisms belonging to the streptothrix group. Strictly speaking, it is not a specific disease like tuberculosis but a group like the suppurative diseases. The organisms form colonies

in the tissues resembling those of the bovine disease, but the radial arrangement at the periphery is often ill marked, and clubs are absent or ill developed (Fig 30) The cultural characters differ greatly in different cases, and the organisms causing the disease have not yet been fully investigated All the streptothrices which affect man stain by Gram's method

The disease is found to be not uncommon when a systematic examination is made of the pus, etc., from all patients treated, when this is not done a considerable number are diagnosed as tuberculosis or syphilis It usually occurs in farmers, millers, and others who are brought in contact with grain, and in a few cases infection from these materials may be definitely traced In many cases the fungus enters the body from a curious tooth or from the tonsil, and the primary lesion is usually somewhere in the region of the mouth Less frequently it may occur in other parts of the alimentary canal, especially in the caecum, appendix (causing a condition which may not be diagnosed from ordinary appen-



FIG 31 — CERVICO-FACIAL ACTINOMYCOSIS (BY KIND PERMISSION OF MR MALCOLM MORRIS)

dicitis in the absence of a microscopic examination), or in the liver giving rise to a very characteristic reticulated swelling, in which diffuse suppuration may occur Again, it may be primary in the lung, causing lesions similar to those of tuberculosis and often giving rise to localized empyemata The skin may also be affected, but in the majority of cases only by extension from the deeper tissues Lastly a few cases of primary actinomycosis of the central nervous system have been recorded

The structure of these lesions resembles that of a tubercle, except that giant cells are perhaps less frequent (the disease being usually more rapid), and the centre of the nodule is occupied by a characteristic colony of the fungus At a later period the lesion breaks down and forms pus, containing the granular nodules described above The disease has a tendency to spread locally, and, although not dangerous in itself, may become so by attacking important organs, or by becoming generalized, giving rise to pyæmic abscesses in all parts of the body

The commonest site for the primary lesion is close to the angle of the jaw, where it constitutes a cervico facial tumour of tolerably characteristic appearance. At first the mass has a smooth, regular, and even surface, and merges gradually into the surrounding tissues, the skin over it is usually hyperæmic. As time passes, little nodular excrescences with a peculiar yellowish apex form here and there on the surface of the tumour, and these finally soften, point, and burst, giving exit to a small amount of glutinous pus, in which the actinomycotic nodules can be demonstrated. When all the fungus has been discharged, the abscess contracts and the wound closes. The cicatrization induced by the constant repetition of this process makes the surface of the mass curiously nodular and puckered (Fig 31), and this condition, when present, is almost pathognomonic. Trismus is an almost constant symptom in the cervico facial form of the disease, coming on early, and being apparently independent of the size of the mass or its involvement of nerves.

The Treatment most recently advised consists in the administration of large doses of iodide of potassium (grs 20 or 30 three times a day), which seems to have almost as great an influence in this disease as in syphilis. This alone may suffice when there is no open wound but if open sores are present, surgical measures must also be employed. Extirpation of all the infiltrated tissue, either by the knife or by vigorous scraping, should be undertaken, and the part freely cauterized. In fact, it must be treated in exactly the same way as a diffuse tuberculous mass. This can, however, only be very partially carried out in the visceral affections.

## CHAPTER VIII

### TUMOURS AND CYSTS

ALTHOUGH the term 'tumour' is often used for any abnormal swelling which may be met with in the body, yet for scientific purposes its application is much more limited. A tumour may be defined as 'a mass of new formation that tends to grow or persist, without fulfilling any physiological function, and with no typical termination'. The fact that it has no typical termination distinguishes it from inflammatory overgrowths, which always lead sooner or later to the formation of fibro cicatricial tissue or some modification of it, inflammatory growths, moreover, may disappear completely, and often diminish in size temporarily. Pure hypertrophies are excluded by this definition, since they always depend more or less on some increased physiological function, and are composed of an increased development of normal tissues, as, for instance, the blacksmith's biceps. Congenital overgrowth of a limb or portion of a limb also occurs, and is known as 'gigantism', it cannot be considered a tumour, being merely an exaggerated development of normal tissues.

The *Ætiology* of tumours is still obscure, the most definite fact being that in a considerable number of cases (variously calculated at 7 to 14 per cent) they follow and appear to be caused by some *injury* or *irritation*, which determines an abnormal development of some of the tissues of the part. Thus an adenoma of the breast is often attributed to a blow, and the irritation of a clay-pipe may produce epithelioma of the lip. In some cases the irritation may be due to chemical substances such as soot (in the case of chimney-sweeps), tar, or petroleum, all of which occasionally lead to the production of epithelioma in persons brought much into contact with them, except in these cases, *occupation* is not known to exercise any influence in the causation of tumours.

The question of *heredity* as a predisposing factor is still unsettled. It was formerly thought to be of considerable importance, but recent observations and statistics have not strengthened this view.

The *geographical distribution* of tumours has only been investigated in the case of cancer. The results of different series of observations have been fairly concordant, and tend to show that the disease is most common in low-lying, damp, well-wooded areas,

especially if they are liable to periodical floods, as, for example, the Thames Valley. It also seems proved that certain houses claim more than their average proportion of victims from cancer—in other words, that cancer is to a certain extent a house disease. This has been taken to indicate an infectious origin for the disease, but other interpretations are possible.

The *age-incidence* varies with the type of tumour. Most innocent forms may occur at any age, though to this rule there are several interesting exceptions—*e.g.*, the adenomata of the breast, which grow only during the period of functional activity of the gland, the fibro-miomata of the uterus, which commence and grow only during the epoch of child bearing, certain osteomata, which form exaggerations of normal tubercles of bone, and grow only whilst the bone grows, and some enchondromata, which arise from ossifying cartilage and continue their growth only during the activity of that structure—*i.e.*, until it becomes ossified. In the malignant tumours the age-incidence is better marked. Sarcomata occur at all ages, but are especially common in the first half of life, whilst carcinomata are very rare before the age of thirty, and are most common after the age of forty.

The effect of *sex* on the incidence of the innocent tumours and the sarcomata is not marked. Women are more liable to carcinomata than males, but this is in large measure owing to the frequency with which this disease attacks the uterus and female breast, cancer of the mouth and other portions of the alimentary canal is more common in men than in women.

Many theories have been brought forward to explain the *pathogenesis* of tumours, but the only ones that need be mentioned are the three following. (1) The *parasitic* theory rests partly on analogy with undoubtedly infectious diseases and partly on direct observation of the supposed parasite, and has been formulated chiefly for the malignant growths. There is at first sight a close clinical similarity between the infective granulomata, especially tubercle and cancer, in each there is a primary lesion marked by invasion and destruction of tissues, followed by secondary growths in the glands or internal organs, reproducing the structure of the primary focus. But the analogy is only superficial, the secondary tubercles are due to the carrying of the infective agents (the bacilli) in the blood or lymphatic stream to distant regions, where they are deposited, and continue to grow and give rise to an inflammatory reaction. The secondary nodules of cancer are caused by the transference in the blood or lymph of actual cancer cells derived from the primary tumour, which are deposited elsewhere, and continue their growth undisturbed, in spite of their change of environment. So-called 'cancer parasites' have been described by numerous pathologists, and have been identified as protozoa or as blastomycetes. They are now generally recognised as leucocytes or red corpuscles, which have entered cancer cells and undergone various forms of degeneration, or as portions of nuclei, paranuclei, etc. A few investigators claim

to have cultivated blastomycetes from cancers, and to have produced cancers by the injection of the cultures into animals, but these results have not been generally accepted

Cancers are inoculable, but only into the same species of animal—*e.g.*, cancers occurring in mice can be inoculated into mice, but not into other animals, and cancers in man are auto inoculable (*e.g.*, epithelioma of one labium may infect the other by contact), but cannot be transmitted to the lower animals. This is not to be regarded as a proof of its infectious nature, the living cells which are transplanted continue to grow, just as they do in the formation of secondary growths.

2 The theory of *fœtal residues* was originated by Virchow's suggestion that in the ossification of cartilage small islets might be left, which subsequently grow and develop into enchondiomata, the idea was at a later date expanded by Cohnheim to include all tumours. It certainly affords an explanation of some varieties of growth, such, for instance, as the dermoid cysts which originate in portions of epidermic structures left behind during embryonic development. But it is not a complete explanation, since it is obviously inapplicable to the formation of epitheliomata in scars, and even where it may apply, no reason is assigned why the embryonic 'rest' should suddenly take on renewed growth in after-life.

3 Ribbert's theory of *tissue tension* is especially applicable to the carcinomata, and attributes the initial defect to a weakness in the connective tissues in proximity to the epithelial cells, so that the latter are allowed to proliferate and invade the surrounding structures. The balance of evidence seems decidedly opposed to this theory, although it affords a satisfactory explanation of the frequency of carcinomata in advanced life, when the vitality and resisting power of the tissues may be assumed to be lowered.

Tumours may be divided into two great classes from a clinical standpoint, *viz.*, the benign and the malignant.

**Benign or Simple Tumours** are characterized by the neoplasms being ~~strictly local, by their~~ more or less exact limitation, being frequently encapsuled, and by their method of growth, which results from a proliferation of all the cells constituting their structure. There is no tendency to infiltrate or invade surrounding tissues, which are merely pushed aside and compressed, pain and atrophy are sometimes caused by this pressure. The capsule is formed by an ensheathing layer of fibro cellular tissue, the outcome of the chronic irritation and inflammation engendered by the growth and development of the mass, hence enucleation is easy, and recurrence uncommon. They are not unfrequently multiple, and may be hereditary, but these characters are no evidence of a constitutional taint.

**Malignant Tumours**, unless removed by operation, are almost invariably fatal. The following are the chief characteristics of malignancy (1) The primary growth is usually single, rarely multiple (2) It progresses steadily and constantly, but with

varying rapidity in different cases (3) The local development is characterized by an infiltration of the surrounding tissues, which are gradually replaced by the tumour substance. A capsule is rarely formed, or, if at all, only in the early stages, and thus the limits of the growth are not clearly defined. Moreover, many varieties spread locally along the efferent lymphatics, and hence, although the growth may appear to have been completely excised, recurrences are very common, owing to the non removal of these invisible extensions of the disease into apparently normal tissue. If a malignant tumour with all its ramifications is completely removed, it does not recur. The impossibility of knowing whether all the growth has been removed, or how far it has extended into the surrounding tissues, is responsible for the frequent recurrences. (4) When a malignant tumour invades the skin, it usually leads to ulceration and is very liable to septic infection, and then not uncommonly a foul fungating mass results (the *fungus hæmatodes* of the older pathologists). (5) Secondary deposits due to embolic dissemination of the cells of the growth are often found in neighbouring lymphatic glands or distant viscera. (6) An apyrexial cachexia develops in the later stages, partly due to the pain, partly to the pressure of the growth on important structures, and in part to the absorption of toxic products from the tumour. The patient becomes thin and emaciated, the face drawn and with an expression of pain on it, the appetite is impaired, and the skin often sallow and earthy-looking. (7) Finally, death ends the scene, after a longer or shorter period of suffering.

The degree of malignancy varies with different tumours. In some the local phenomena predominate, whilst in others the constitutional symptoms are the more important. Thus, rodent ulcer is slow in its progress, and produces no visceral deposits, it destroys life merely by implication of vital parts. Melanotic sarcoma, on the other hand, may produce only a small primary growth, but the most extensively diffused secondary deposits may form in the viscera. The sarcomata are usually disseminated by the blood stream, and hence secondary growths are not very common in lymphatic glands, whilst the carcinomata spread by means of the lymphatics. Even among the latter considerable differences are manifested, thus, in glandular cancer secondary growths occur both in the lymphatics and the viscera, whilst in squamous epithelioma neighbouring lymphatics are affected, but the viscera generally escape.

Recently it has been shown that there is a profound structural difference between malignant tumours on the one hand and benign tumours or inflammatory lesions on the other. The difference exists in the characters of the mitotic figures seen in dividing nuclei. These are of two sorts. In simple tumours and in inflammatory lesions the mitoses are of the somatic type—*ie*, similar to those occurring in the development of all the cells of the body other than the ova and testes. In malignant tumours there are some mitoses of this nature, but cells may also be seen which are undergoing a

heterotype form of division, such as is only observed normally in the formation of the generative cells. The main difference is in the number of chromatin filaments, of which there are (in man) thirty-two in somatic mitosis, and sixteen in the heterotype form. In other animals other numbers occur, but the one is always exactly half of the other. These facts are as yet unexplained, but they are of profound theoretical interest in relation to the nature of malignant growths.

**Classification of Tumours** —The following is a practical scheme of classification, based partly on the structure of the tumour, and partly on that of the tissue from which it originates.

# I Tumours derived from the Connective Tissues

## (a) Of embryonic type

Sarcoma

## (b) Of adult type

Myxoma (mucoid tumour)

Lipoma (fatty tumour)

Fibroma (fibrous tumour)

Chondroma (cartilaginous tumour)

Osteoma (bony tumour)

Myoma (muscle tumour)

Neuroma (tumour in connection with nerves)

Glioma (tumour of neuroglia)

## (c) Formed of combinations of simple tissues

Angioma (tumour composed of bloodvessels)

Lymphadenoma, or lymphangioma (tumours of lymphatic origin)

Odontoma (tumour connected with the teeth)

**II Tumours composed Wholly or Chiefly of Epithelium** —These may resemble papillæ or glands, or may infiltrate the connective tissue in a wholly irregular way, and hence may be subdivided as follows

## (a) Tumours resembling papillæ

Papilloma	{	Squamous-celled
		Cuboidal-celled
		Columnar-celled

## (b) Tumours resembling glands

Adenoma	{	Cuboidal-celled
		Columnar celled

## (c) Atypical tumours

Carcinoma	{	Squamous celled (epithelioma)
		Cuboidal-celled (glandular carcinoma)
		Columnar-celled

# III Tumours growing from Endothelium

Endothelioma

# IV Tumours formed by the Inclusion of Part of another Embryo

Teratoma



## I The Connective-Tissue Group of Tumours (1) Tumours composed of Embryonic Connective Tissue

**Sarcoma** (= a flesh-like tumour, Greek, *σαρξ*, flesh) — A sarcoma is a malignant tumour which is derived from connective tissue. Like all tumours, it consists of a parenchyma, formed of cells which have taken on the power of continued and apparently limitless growth, and of a more or less inert supporting network or stroma consisting of fibrous tissue, bloodvessels, etc. It is characteristic of the sarcomata that these two elements are intimately mingled together, each parenchyma cell being separated from its neighbours by delicate fibrillæ of the stroma, in the other great group of malignant tumours (the carcinomata) this is not the case, since the parenchyma cells occur in masses or alveoli which are enclosed by, and sharply marked off from, the stroma. The parenchyma cells of the sarcomata are of mesoblastic origin, and resemble the cells from which the connective tissues are formed in the embryo both in shape and in their capacity for continued growth, hence they are often referred to as embryonic connective-tissue-cells. There is, moreover, a great resemblance between the sarcomata and inflammatory new formations, which are also composed of mesoblastic cells which have assumed the power of growth, and this resemblance is increased by the fact that in both cases these embryonic cells may undergo organization into more mature forms of connective tissue, such as fibrous tissue or bone. There is, however, this marked difference between the two the inflammatory new formations arise as the result of a definite irritant, and cease to spread when that irritant ceases to act, whereas the sarcomata usually arise without apparent cause, and continue to spread indefinitely.

A sarcoma may at first be well defined or even encapsulated, but many forms from the first, and all later on, infiltrate the surrounding tissues, replacing them with their own particular structure, a process which can be well observed in sarcomata of muscles. The blood-supply is very abundant, and, indeed, may be so free as to cause the tumour to pulsate. The vessels consist of spaces or clefts within the tumour substance, and are lined merely by the most delicate endothelium, the arteries and veins in the neighbourhood are much dilated. Interstitial hæmorrhage is frequent, owing to the thinness of the vessel walls, and cysts may in this way be produced. *Dissemination* is usually dependent on the relation of the tumour to the veins. As already stated, the veins communicate with spaces hollowed out of the tumour substance, into and along these the sarcomatous tissue may burrow, until the apex of this intravascular growth projects into the lumen of a vessel in which the blood is freely circulating. It may be detached by some slight mechanical injury, and is then carried away as a malignant embolus, if a large portion is set free, it may lodge in the right side of the heart, or in the lungs, and cause a fatal result. Smaller emboli are either detained in the lungs, or pass through into the general circulation, giving rise to

secondary growths wherever they are arrested, it is quite usual for general visceral implication to be secondary to the pulmonary growths. Nothing is known as to the existence of nerves or lymphatics in sarcomata, occasionally, however, dissemination by way of the lymphatic glands is met with, especially in melanotic sarcoma, lympho sarcoma, and sarcoma of the tonsil, testis, and thyroid body.

The various forms of sarcomata described below have a tendency to become organized into tissues which bear a close resemblance to the normal connective tissues, and tumours in which this process has taken place to a marked extent often receive special names, *e.g.*, fibro sarcoma, in which the parenchyma cells become organized into fibrous tissue, osteo-sarcoma, in which they develop into bone, chondro-sarcoma, and lipo-sarcoma.

Degenerative changes are also apt to occur in the older portions of a sarcoma, but not at the spreading edges, so that the malignancy of the tumour is not thereby affected. Fatty degeneration is the commonest, and leads to the formation of a tumour, which must be distinguished from a lipo-sarcoma, mucoid softening may also take place, and tumours in which this has happened are often known as myxo-sarcomata. Hæmorrhage is frequent into the softer varieties, and calcification is not unfrequent in the more chronic forms.

On naked-eye examination, a sarcoma presents a more or less homogeneous appearance, the colour varying with the amount of the blood-supply, from a grayish white in the fibro-sarcomata to a deep maroon colour in the myeloid. On scraping the cut surface, juice, like that from a cancer, is never obtained, even when the tumour has been removed from the body for some time, and thus the cohesion of the cells impaired, a milky substance then sometimes appears, whilst in myeloid sarcoma a slimy fluid escapes, but it in no way resembles that obtained from a cancer.




FIG. 32.—SMALL ROUND CELLED SARCOMA INFILTRATING MUSCULAR TISSUE (TILLMANN'S)

This form of malignant disease occurs most commonly in young and middle aged people, especially affecting the first and fourth decades of life, it may also be congenital. The degree of malignancy varies considerably, some forms being almost benign, or, at any rate, only locally malignant, whilst others are exceedingly virulent in nature.

Sarcomata are divided artificially into the following groups, depending on the size, shape, arrangement, and character of the constituent cells. (a) The round-celled, (b) the spindle-celled, (c) the myeloid, (d) the alveolar, and (e) the melanotic.

(a) **Round-celled Sarcomata** (Fig 32) consist of a mass of round cells containing a very definite circular or oval nucleus, the intercellular substance is slight in amount, and often homogeneous in character. The mass is very vascular, and may even pulsate, it is soft, like granulation tissue, and usually grows rapidly. Several subdivisions are described (i) The *small round-celled sarcoma* is extremely malignant, infiltrating surrounding parts, and early giving rise to secondary deposits, lymphatic glands are not unfrequently affected in this variety. The small size of the cells is thought to be an indication of the rapidity of growth, since they divide before having time to grow to a large size. Any part of the body may be involved, and it may be met with at any age. (ii) The *large round-celled sarcoma* is made up of larger cells, which contain one or two large oval nuclei with an abundant protoplasm around. A well-marked stroma is interspersed between the cells, and an alveolar arrangement is sometimes present, it occurs in the same position as the former, but is rather less malignant. (iii) *Lympho-sarcoma* is

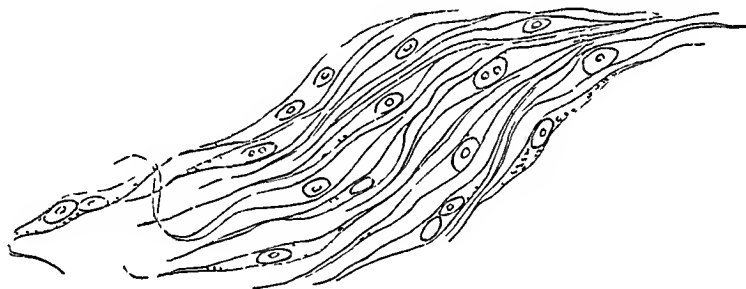


FIG 33 —SPINDLE-CELLED SARCOMA

The individual cells have been separated, and the characteristic nuclei can be seen

very similar in structure, the cells, however, are small, and the intercellular substance is of a delicate reticular nature, corresponding to the retiform tissue commonly met with in lymphatic glands. Such tumours grow rapidly, and are exceedingly malignant, they usually start in lymphatic glands, or in the lymphoid tissue of mucous membranes, and are disseminated by means of the lymphatics. For the clinical characters of these tumours, see Chapter XIV

(b) **Spindle celled Sarcomata** (Fig 33) consist of large or small spindle-cells, which are often arranged in a somewhat fasciculated manner with a greater or less amount of intercellular substance. When consisting of *small cells*, the tumour grows rapidly, and is firmer and less succulent than the round-celled variety. They may originate in any part of the body, but more especially from aponeuroses, fasciæ, tendons, etc, constituting localized growths, which are at first tolerably well defined, but later on invade and infiltrate surrounding parts. When growing rapidly, the cells become less fusiform in

shape, and may even approach to the round cell in character, after passing through a stage known as the oval or oat-shaped sarcoma. These tumours, consisting of small spindle cells, are usually very malignant in character. In some cases the cells undergo organization into well-formed fibrous tissue, and the tumour closely resembles a simple fibroma, being well encapsuled, so that it can be shelled out with ease. These tumours are known as fibro-sarcomata ('recurrent fibroid' tumours of Paget), and are not uncommon in the sub-cutaneous tissues. They are on the border-line of malignancy, since they rarely form secondary growths, and often do not return for two or three years after removal. But they usually recur more rapidly



FIG 34 — MYELOID SARCOMA SHOWING THE MULTI-NUCLEATED MYELOID CELLS (MYELOPLAXES) LYING AMONGST THE MORE ABUNDANT SPINDLE CELLS (GREEN'S PATHOLOGY)

after each operation and show signs of greater malignancy, until, after, perhaps, being removed a dozen times, they recur with all the characters of an ordinary spindle celled sarcoma.

The *large spindle-celled sarcomata* are softer and of a deeper colour than the former. They grow from the fibrous tissues, and not uncommonly from the viscera. The congenital sarcoma of the kidney is of this nature, though some of the cells become transversely striated, looking like muscle fibres, such tumours are sometimes called 'myo-sarcomata'.

(c) Myeloid Sarcomata (Fig 34) are characterized by the presence of large numbers of multi-nucleated giant cells (*myeloplaxes*), imbedded in a considerable quantity of round or spindle cells, the intercellular substance being usually of a gelatinous nature. The

myeloid cells vary a good deal in size, but always contain a large number of distinct nuclei, which are not distributed regularly in the periphery of the cell, as in the case of the giant cells of tubercle, they may be regular in outline, or prolonged into numerous interlacing processes, although these latter are usually not very evident. There is also no definite arrangement of cells around them, as in the tubercular giant-cell systems. These tumours are soft in consistency, and on scraping a slimy fluid is obtained. They are exceedingly vascular, and may pulsate. Hæmorrhage into their substance is common, giving rise to cysts, filled with serum and a yellowish fibrinous clot stained with the colouring matter of the blood. When fresh, the growing edge is of a dark maroon colour on section, and has been likened to the appearance of a pomegranate, when preserved in spirit, these tumours are always of a characteristic brown colour,



FIG 35 —ALVEOLAR SARCOMA  
(TILLMANNS)

The individual cells in the alveoli are here apparently lying in close contact, but in reality there is a certain amount of intercellular substance placed between each of them.

owing to the formation of hæmatin. They are the least malignant of all the sarcomata, but rarely or never giving rise to secondary deposits, either in the lymphatic glands or viscera. Their growth is tolerably rapid, and they may attain enormous dimensions. Myeloid sarcoma is almost invariably found growing from bones, for the particular sites, symptoms, and treatment, see Chapter XX. A certain amount of doubt exists as to whether these tumours should be included amongst the sarcomata, since their clinical history and progress are of a benign type, and the term 'myeloma' has been suggested for them, as indicating in measure their nature and structure.

(d) **Alveolar Sarcoma** (Fig 35) is a variety in which the cells are grouped together in alveoli, separated by a distinct fibrous stroma. On microscopic examination they closely resemble cancer, but on carefully pencilling a section with a camel's-hair brush, it will be found that the stroma sends delicate prolongations between each of the cells. This variety of tumour is most commonly found growing from the skin, and is occasionally of a melanotic nature, and always very malignant.

(c) **Melanotic Sarcoma** is the most virulent of all this group of tumours, because of the early date at which it forms secondary deposits in lymphatic glands and internal organs. It grows from those portions of the body which are naturally pigmented, especially the choroid coat of the eye and the skin. Those growing from the former situation are usually composed of spindle cells, all of which contain granules of melanin, these choroidal tumours are true

sarcomata, and have a special tendency to form secondary deposits in the liver. The melanotic tumours of the skin most frequently develop from pigmented moles. They have an alveolar structure, and were formerly regarded as alveolar sarcomata, but most pathologists now follow Unna in regarding the tumour cells as being derived from downgrowths of the surface epithelium, and classify the tumours themselves as carcinomata. The pigment granules in this form are very unevenly distributed, some lying in the stroma between the alveoli, whilst others are contained in the cells, some portions of the primary tumour are often quite free from pigment, and some of the secondary growths are often colourless, whilst adjacent growths may be absolutely black. The nature of the pigment (melanin) is still uncertain, but the fact that it does not contain iron seems to indicate that it is not derived from hæmoglobin. It may be deposited in the skin of the patient apart from the tumours (melanosis), or may be excreted in the urine.

If the primary tumour is not removed very early, the nearest lymphatic glands are soon affected, and secondary deposits in the viscera follow. The original tumour is often not very large, and the secondary deposits are similarly characterized by their number rather than by their size, scarcely an organ in the body being free.

Of late years a more benign type of melanosis has been described and is now well recognised by dermatologists. It usually spreads from a congenital mole as a deeply pigmented patch, which may extend over an area of several square inches and presents at first no sign of induration or infiltration. In this stage microscopic examination reveals no change in texture except pigmentation of the deeper layers of the cutis vera. Sooner or later, a tumour develops in the centre of this patch, and may be either a sarcoma or a cancer, but more frequently the former. It is not very rapid in its course, but if left alone will finally become disseminated. In treating this type of melanosis, it is essential to remove every portion of pigmented tissue as well as the tumour.

The **Treatment** of sarcoma consists in its removal as early and completely as possible. This may be a simple matter in cases where the tumour is encapsuled, but even then recurrence is very likely to follow unless the capsule is also taken away, and a considerable margin of tissue beyond it. Where, however, the growth is more diffuse, the only hope lies in cutting widely, so as to get beyond its furthest limits, the prognosis of such cases is very bad.

In hopelessly *inoperable* cases somewhat similar measures have been employed as for the similar stage of cancer (*vide* p 210). Several cures have now been recorded from the use of Coley's fluid, which consists of a sterilized culture of the *Streptococcus erysipclatis* and *Micrococcus prodigiosus* in bouillon. This fluid is intensely toxic, and the injections, commencing with doses of half a minim, are gradually increased up to 7 or 8 minims, severe reaction usually follows, and the surgeon should aim at obtaining two or three such effects each week. The fluid is introduced partly into the abdominal wall, and partly into or around the tumour. In favourable cases the growth gradually dwindles. The spindle-celled sarcomata are

apparently the most suitable for this treatment, whilst ossifying and melano-sarcomata are but little, if at all, affected As to the value of X rays for sarcoma, see p 210

## (2) Tumours consisting of Connective Tissue of Adult Type

**Myxoma** —A myxoma is a tumour consisting of connective-tissue cells, surrounded by and separated from each other by an intercellular substance of a mucoid character, a similar type of material occurs normally in the substance of the umbilical cord The cells are usually polygonal in shape, and present long branched processes which interlace with those from adjacent cells (Fig 36) The intercellular substance is homogeneous and translucent, containing

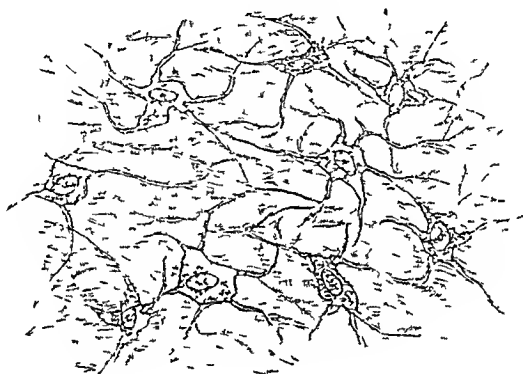


FIG 36 —MYXOMATOUS TISSUE, SHOWING THE STELLATE CELLS, WITH THEIR BRANCHING PROCESSES SEPARATED BY TRANSLUCENT INTERCELLULAR SUBSTANCE (TILLMANN'S)

wandering connective-tissue corpuscles, and traversed by blood-vessels, the density of the tumour varies inversely with the amount of intercellular substance It is not uncommon for this form of growth to be associated with sarcoma, and hence a thorough and early removal of the mass is always advisable

Myxomata occur as rounded tumours, perhaps lobulated, in the neighbourhood of mucous membranes—*e g*, the face, intestine, and bladder, they also grow in the sheaths of nerves, and are the commonest form of simple tumour of the spinal cord Mucous polypi of the nose were formerly considered, of this nature, but at the present time rhinologists look on them as merely consisting of œdematous granulation tissue

**Lipoma** —A fatty tumour is an overgrowth of fibro-cellular tissue, infiltrated with fat On microscopical examination it differs in no respect from ordinary adipose tissue, and is not very freely supplied with bloodvessels

When localized (Fig 37) it forms a tumour, soft and semi-fluctuating in consistence, rounded and lobulated in outline, and if

occurring in the subcutaneous tissues, the skin becomes dimpled on moving it from side to side, owing to the fact that fibrous trabeculae pass from the capsule to the skin. The growth is usually encapsuled and freely movable, but if exposed to pressure or friction, as when situated on a man's shoulder and rubbed by the braces, it becomes firmly adherent to surrounding structures. Such growths are either single or multiple, in the latter case perhaps occurring in hundreds, and are most commonly found about the trunk or the upper extremities. It has been stated that lipomata travel from one part of the body to another under the influence of gravity, but it is somewhat doubtful whether this ever occurs. Occasionally subcutaneous tumours become pedunculated and pendulous.



FIG. 37.—LIPOMA, SHOWING CHARACTERISTIC LOBULATED OUTLINE (FROM KING'S COLLEGE HOSPITAL MUSEUM)

Deep intermuscular lipomata are sometimes met with, and the diagnosis may then be uncertain, since their mobility and lobulated outline are masked by the superjacent tissues, they have even been mistaken for sarcomatous growths. Still more difficult of recognition are those known as **parosteal lipomata**, growing from the outer surface of the periosteum. They are often congenital, and appear as soft swellings, lying beneath the muscles in close proximity to a bone and suggesting the presence of a chronic abscess.

**Pericranial lipoma** is of a somewhat similar nature. It is usually congenital in origin, and the cranium may be hollowed out beneath it. An angiomatous element is sometimes present in these growths.

By the term **Diffuse Lipoma** (Fig. 38) is meant a fatty infiltration of the subcutaneous tissues of some region of the body, particularly beneath the chin and at the back of the neck, and more rarely in the pubic region. These growths are often multiple and almost always symmetrical. They usually occur in individuals who drink beer freely and take but little exercise. Their size diminishes on limiting the amount of alcohol and making the patient do physical work.

Occasionally the connective-tissue basis of a lipoma undergoes modifications, e.g., it may become increased in amount, constituting a **Fibro-lipoma**, or be transformed into mucoid tissue, giving rise to a **Myxo-lipoma**, or, again, the vessels may become dilated, originating a **Nævo-lipoma**, and even a **Sarco-lipoma** may develop.



Localized or diffuse overgrowths are often met with in the sub-peritoneal fatty tissue, constituting **Subserous Lipomata**. They occur not unfrequently in the lower part of the abdomen, and may extend into the inguinal and crural canals, forming the so called fatty tumour in these parts. By their traction a process of peritoneum may eventually be drawn down, and a true hernia produced.

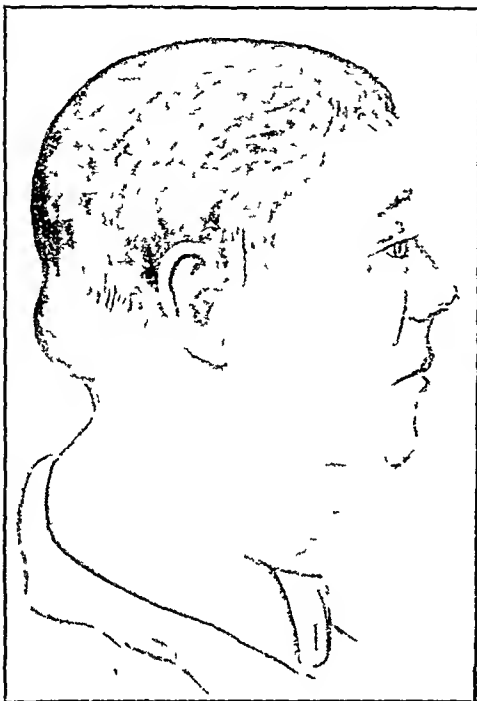


FIG 38 —DIFFUSE LIPOMA

A similar condition occurs in the anterior abdominal wall, small pedunculated masses of fat projecting through congenital or acquired openings in the linea alba or linea semilunaris, these are sometimes known as **Fatty Hernia of the Linea Alba**, and are often painful.

**Lipoma Arborescens** is the term applied to a villous outgrowth of fatty tissue, met with in the interior of joints, and usually associated with osteoarthritis. There is often a considerable increase in the amount of intra-articular fluid, and the condition has then been designated 'synovitis lipomatosus'.

The **Treatment** of lipomata consists in their removal. When they are loosely encapsuled, this is a very simple matter, all that is required in

many cases being to squeeze the mass forwards between the thumb and finger, making the skin tense over it, and then to incise the capsule freely, when the tumour almost jumps out, but if there are many adhesions it may not be so easy. In the *diffuse* forms dietetic and hygienic measures should first be tried. Should an operation be required, it is well to cut through the whole thickness of the tumour at once, and deal with each half separately, dissecting it away from its deep attachments.

**Fibromata** consist of overgrowths of fibrous tissue, they were formerly divided into two groups, the **hard** and the **soft**, and although there is no essential difference between them, it is a useful clinical distinction.

The **Hard Fibroma** is composed of firm dense tissue, which creaks on section with the knife, the exposed surface showing numerous trabeculae of glistening fibres, similar in character to those met with in a tendon (Fig 39). Microscopically, interlacing fibrillae are seen,

which are sometimes arranged concentrically around the blood-vessels, there are but few nucleated cells in the more slowly growing tumours. The vascular supply is somewhat defective, although dilated veins are often present in the capsule, and sometimes in the substance of the mass, these, if opened by ulceration, may lead to profuse hæmorrhage. Hard fibromata are met with in the form of *epulis*, *fibrous polypus of the nose*, *keloid*, and not uncommonly in the sheaths of nerves.

**Soft Fibromata** develop as localized overgrowths of the subcutaneous fibro-cellular tissue, or as the so called **Molluscum fibrosum**. In the latter case many different forms of the growth are met with, sometimes many small nodules develop, scattered widely

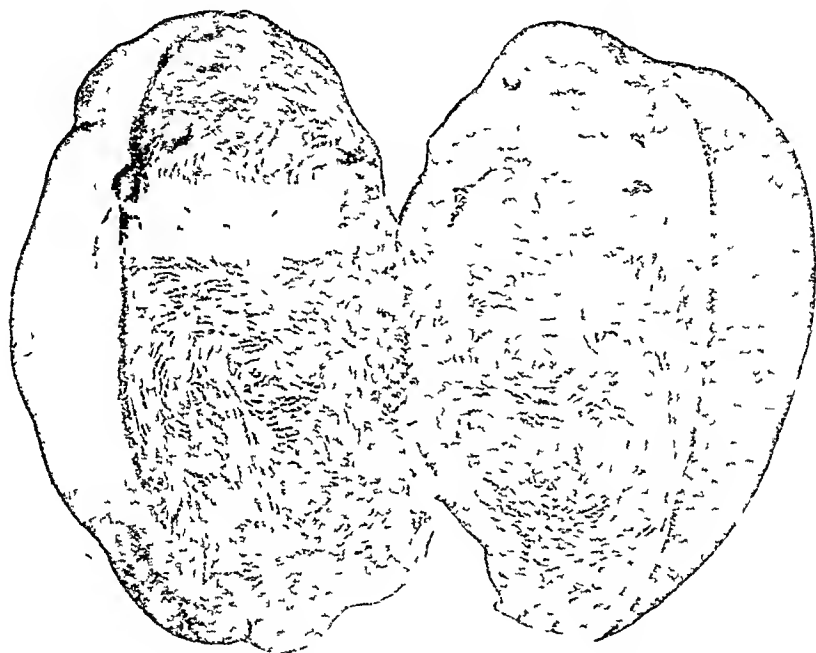


FIG 39.—SECTION OF HARD FIBROMA (ROYAL COLLEGE OF SURGEONS MUSEUM)

over the surface, usually pinkish, and with the skin over them somewhat corrugated, these may be associated with changes in the underlying nerves (p 196). It also exists in the form of pendulous folds, perhaps involving a large area of the trunk, the so called pachydermatocele of the scalp is of this nature.

**Chondroma.**—Cartilaginous tumours are met with growing in connection with either bones or cartilages. They consist of hyaline cartilage, which, instead of being uniform in texture and devoid of vessels as at the articular ends of bones, occurs in the form of pellets or nodules of varying size, held together by vascular connective tissue, which may even penetrate into the substance of the

**cartilage** The cells are also less regular in shape than is the case with normal cartilage, and are not arranged according to any definite plan

**Chondromata** are liable to become calcified, and even ossified. When large, the central parts may undergo a mucoid change, giving rise to a cavity which, if sepsis is admitted, becomes exceedingly foul. They are not uncommonly accompanied in their growth by sarcomatous and other elements.

When growing *from the long bones*, chondromata usually start from beneath the periosteum, and are independent of the epiphyseal cartilage, although it has been suggested by Virchow that they may originate from a nodule of cartilage which has been displaced from its usual situation during an attack of rickets. They constitute firm lobulated encapsuled tumours, and give rise to no pain, except when they encroach on neighbouring nerves. They often attain a great size. The growth may extend secondarily into the medullary canal, and thus cause expansion of the bone, or it may erode the compact tissue, and lead to spontaneous fracture. Amputation of the limb will probably be necessary, unless the case comes under observation in the early stages, when the tumour can be gouged or scraped away.

Chondromata also originate *from the smaller bones*, usually from those of the hand (Fig 40). In such cases the growth commences in the interior, close to the epiphyseal cartilage, several tumours may be present in the same individual. The bone is expanded by the growth, and the part becomes much deformed. Treatment consists in incising the capsule, and scooping out the cartilaginous tissue, a proceeding which may result in defective growth and subsequent deformity. In the later stages, however, amputation is inevitable.

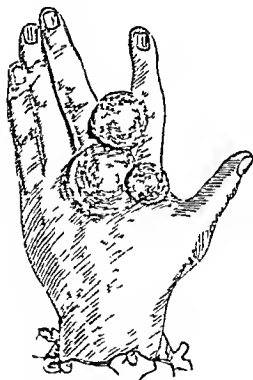


FIG 40 — MULTIPLE  
CHONDROMATA OF  
THE FINGERS

Overgrowths of cartilage, known as **Echondroses**, occur around the articular cartilages in connection with osteo-arthritis, they also arise from the cartilages and septum of the nose, and from the laryngeal cartilages. Some of the loose bodies which

form in joints are of a similar nature

**Osteoma** — Bony tumours are of two chief forms the cancellous and the ivory

**Cancellous Osteomata** are usually met with growing near the articular end of a bone, being derived originally from some isolated portion of the epiphyseal cartilage, which has perhaps been separated from its original connection after an attack of rickets. It is well known that in this affection irregular outgrowths from the epiphyseal cartilage occur, and if one of these near the periphery of the bone

## PLATE II



EXOSTOSIS OF THE RADIUS

This growth occurred in a young man aged twenty-three years. It will be noticed that it has caused great deformity of the ulna and, indeed apart from the skiagraph, one might have supposed that it had originated from that bone.



becomes shut off from its epiphyseal attachment, it is easy to understand its development into a tumour, which consists of cancellous bone, capped by a layer of hyaline cartilage, from which it grows (Fig 41) It is pedunculated or sessile, and may attain to a large size, leading to considerable deformity (Plate II) It necessarily develops in young people, and may be congenital As the individual grows, the basis of attachment may become separated from the epiphysis to an extent corresponding to the amount of growth which has taken place at that spot, or it may still remain attached to the epiphyseal line As a rule its growth and development cease at maturity, when the cartilage covering it, as well as the epiphyseal

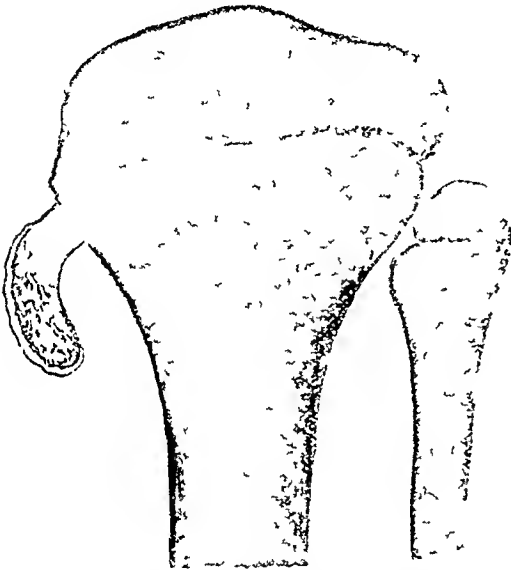


FIG 41 —SEMI-DIAGRAMMATIC REPRESENTATION OF CANCELLOUS EXOSTOSIS OF THE UPPER END OF THE TIBIA (FROM A SKIAGRAM)

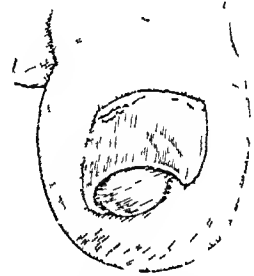


FIG 42 — SUBUNGUAL EXOSTOSIS (BLAND SUTTON)

The patient had many other exostoses including one growing from the neighbourhood of the adductor tubercle of the femur, and another from the outer side of the head of the tibia in front of the fibula which has been omitted in the diagram The cartilaginous cap covering the cancellous tissue is clearly indicated

cartilage, ossifies A bursa occasionally forms over the most prominent part of these tumours as a result of friction or pressure, giving rise to the condition known as **Exostosis Bursata**, this cavity may communicate with the joint An effusion of blood or serum into the bursa may be the first evidence of the existence of such a growth Multiple exostoses are not unfrequently met with, and are then often hereditary The most common situation for such a tumour is the inner condyle of the femur, close to the adductor

tubercle, but they are not rare on the inner aspect of the mandible. The **Subungual Exostosis** (Fig 42) develops as a rounded, cherry-like swelling under the nail of the great toe. It is very painful, and should be treated by removing the nail, incising the tissues over it down to the bone, and clipping it away with cutting pliers. Fig 43 represents a skiagram of an exostosis growing from the proximal phalanx of the thumb.

**Ivory Exostoses** develop most frequently on the inner or outer aspect of the cranial bones, especially affecting the orbit, external auditory meatus, antrum, and frontal sinus (Fig 44). They consist of masses of very dense compact tissue, covered by periosteum, from which they grow. They are usually lobulated, and when situated in the frontal sinus, or growing from the under surface of the skull, may give rise to serious symptoms from irritation or compression of the brain or its membranes. In a few cases necrosis has resulted and they have sloughed out, thus bringing about a spontaneous cure.



FIG 43 — SKIAGRAM OF EXOSTOSIS GROWING FROM THE BASE OF PROXIMAL PHALANX OF THUMB SHOWING OPEN CANCELLOUS TEXTURE AND ORIGIN NEAR THE EPIPHYSEAL CARTILAGE

Occasionally diffuse overgrowths of the bones of the skull (**Hyperostoses**) are met with, affecting either the calvarium alone, being then probably syphilitic in nature, or the facial and cranial bones, as in leontiasis ossea. New formation of bone sometimes occurs in the substance of tendons which are exposed to irritation or excessive action, *e g*, the tendon of the adductor longus in riders, producing what is known as 'the rider's bone,' but this is inflammatory in origin.

The **Treatment** of osteomata consists in their removal where possible. This may be tolerably simple in the case of the cancellous osteomata of the limbs, but is sometimes a most formidable proceeding when dealing with sessile compact exostoses of the calvarium.

**Myoma** — Myomata almost always consist of *unstriated* muscle fibres (**Leiomyoma** or **fibromyoma**), forming rounded and often encapsuled tumours, the cells of which are long and fusiform, and contain a rod-like nucleus. Bundles of these cells are grouped together into fasciculi, which are arranged more or less regularly. The tumours themselves are not very vascular, but vessels of considerable size are found in the capsule. It is often difficult to distinguish these tumours microscopically from fibromata on the one hand, and from fibro-sarcoma'ta on the other. From the former they are known by the fact that individual cells can be recognised, and by the absence of wavy tendinous fibrillæ,

from the latter the distinction depends on the facts that other types of tissue may occur in the sarcoma, and that the growing edge is usually more or less embryonic in character, whilst a myoma is of the same structure throughout. Again, in a myoma the blood-vessels have distinct and definite walls, and in a sarcoma they are simply clefts or passages in the tumour substance.

Myomata are met with in the uterus, occasionally in the prostate, and more rarely in the walls of the alimentary canal or in the ovary. Secondary changes sometimes occur, *e.g.*, mucoid softening, as in fibro-cystic disease of the uterus, calcification, ulceration with profuse hæmorrhage, and possibly consequent septic inflammation, whilst malignant disease may supervene.

Tumours consisting of *striated* muscle fibres (*Rhabdomyoma*) have been described, but are exceedingly rare.



FIG 44 —IVORY EXOSTOSIS GROWING FROM FRONTAL SINUS, AND ENCROACHING BOTH ON THE ORBIT AND THE CRANIAL CAVITY (BLAND SUTTON)  
(From specimen in the College of Surgeons Museum)

**Neuroma** —True Neuroma is seldom met with; only five undoubted cases being on record. It is formed by a mass of newly-formed ganglion cells and nerve fibres, which may be medullated or not. In all but one case it involved the sympathetic system, and occurred in children or young people. The tumours may attain considerable dimensions, are often multiple, and may be quite soft, like a lipoma, or firm. They are insensitive and innocent, and may be freely removed.

**False Neuromata**, or those developing in connection with the sheaths of nerves, are more common, and may be described under three headings.

1 **Localized Pseudo-Neuroma**, which may be innocent or malignant, the former being a fibroma or myxoma, the latter usually a



sarcoma It may project from one side of the nerve, or more frequently causes the nerve fibres to be separated and spread out over it (Fig 45) It moves more freely in a direction at right angles to the axis of the nerve than along its course When developing from a small nameless subcutaneous twig, it is termed a *painful subcutaneous nodule*, and then gives rise to intense pain of a neuralgic type, especially when compressed or irritated, or when exposed to cold A false neuroma growing from a larger mixed nerve (*trunk neuroma*) is less painful, because there are relatively fewer nerve fibrillæ, and the mass is less exposed A growth



FIG 45 — PSEUDO NEUROMA  
FIBROUS TUMOUR CROWING  
FROM NERVE SHEATH AND  
CAUSING THE FIBRES TO BE  
WIDELY STRETCHED OVER IT

on a pure motor nerve, though sensitive, is not associated with radiation of pain It is uncommon for tumours of this type to cause complete paralysis or anæsthesia, unless they are of a malignant nature They occur most frequently in healthy adults, and in women a little more commonly than in men

**Treatment** — A neuroma, if painful, should be removed, care being taken, if possible, not to interfere with the continuity of the nerve fibrillæ If this cannot be accomplished, the nerve must be divided, and the ends sutured together

## 2 Diffuse or Generalized Neurofibromatosis (*Recklinghausen's disease*) —

This consists of a diffuse thickening of the nerve sheaths, causing multiple elliptic or spherical tumours, or a

generalized enlargement The growths may be encapsuled and limited, or not, they may be few in number, or hundreds may be present, and they are usually whitish and firm in texture They originate from the endoneurium of the primary nerve bundles Any part of the peripheral nervous system may be affected, including the sympathetics, but it is most common in connection with the cranial nerves and the large plexuses of the trunk The actual symptoms are sometimes very slight, but the tumours may be sensitive to pressure, and some one of them, more exposed than the others, may be exquisitely tender Motor phenomena are rare, and paralysis is usually due to involvement of the nerve roots in the spinal canal, or to the supervention of sarcoma, which is a not uncommon termination The disease may start at any time during life, and although progressing slowly, sooner or later terminates fatally No known *treatment* is of any avail, but should any particular tumour become large and tender, it may be removed

In connection with this disease one frequently finds a large development of fibrous growths of the skin, similar to what we

have already described as *molluscum fibrosum*. On careful microscopic examination of specimens stained by Weigert's method, the presence of nerve fibrillæ can be demonstrated in these growths, showing that they are really neurofibromatous in origin. So excessive does this overgrowth occasionally become that a form of elephantiasis is produced, e.g., the irregular hyperplasia of the scalp tissues known as a *pachydermatocoele*.

A **Plexiform Neuroma** is a special modification of this process, occurring congenitally or in young people, and usually involving the trigeminal or superficial cervical nerves, it may be associated with the former condition. The overgrowth is of a softer, more gelatinous type (myxo-fibromatous), and the resulting tumour consists of a plexus of thickened, tortuous, vermiform strands, of soft consistence, held together by loose connective tissue, but easily separable into their constituent elements, which are of a nodulated character, so that the dissected mass looks 'not unlike grains of boiled tapioca on a string' (Alexis Thomson). The plexiform neuroma is almost always subcutaneous, but often dips deeply between and into the substance of muscles. When limited in extent, the growth may be dissected out, and this is usually required for cosmetic purposes. The final prognosis is rather better than in the former condition, as secondary sarcomatous changes are rare.

3 The bulb formed upon the proximal end of a nerve after its division is sometimes described as a neuroma (**Traumatic Neuroma**). It consists of a mass of fibro-cicatrical tissue containing spaces, coiled up within which are numbers of newly formed axis cylinders (p. 372). They are almost always present in amputation stumps, but are not painful unless adherent to the periosteum of the neighbouring bone, or to the cicatrix, when every movement of the nearest joint causes traction upon them, and induces severe neuralgia.

**Gliomata** are tumours arising from the neuroglia of the central nervous system or retina, and, unlike the tumours described above, are of epiblastic origin. They are most common in the brain and spinal cord, and are very rare in the retina, most of the growths occurring in this region, and supposed to be gliomata, being in reality round celled sarcomata, the distinction is one of some importance, since the true glioma never gives rise to secondary growths (although it may infiltrate locally), and is completely removed with ease, so that recurrence is uncommon. They consist of cells (which may be round, spider shaped or spindle-shaped) and of fibres, these occur in varying proportions in different cases, giving rise to the hard and soft varieties. Their colour often closely resembles that of the brain itself, and there is usually no sharp line of distinction between the tumour and the surrounding tissue, so that they were formerly regarded as malignant and termed *glio sarcomata*. They vary greatly in rapidity of growth and in vascularity.

### (3) Tumours formed of Combinations of Simple Connective Tissues

**Angioma**—Several distinct varieties of tumour consisting of dilated arteries or veins exist, but the term 'angioma' is applied only to those in which a new formation of bloodvessels occurs, hence aneurisms and varicose veins are not included in this category

Three main types of angioma may be described (1) The simple *nævus*, (2) the cavernous *nævus*, and (3) the *plexiform angioma*

The **Simple Nævus** is exceedingly common, and consists of a mass of dilated capillaries, bound together by a small amount of connective tissue. It is usually congenital, and may increase rapidly in size during the first few months of life. It is located in the skin, or may also involve the subcutaneous tissues, but the tubular form

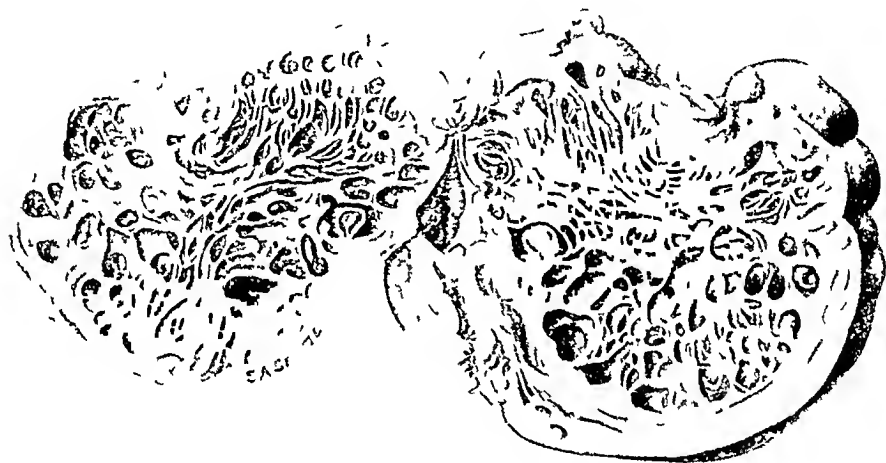


FIG 46—SECTION OF CAVERNOUS ANGIOMA (MUSEUM OF ROYAL COLLEGE OF SURGEONS)

In one or two of the cavernous spaces thrombi more or less adherent can be seen

of the constituent vessels always remains. It may be of a bright red colour or of a dusky tint. For a fuller account, see Chapter XIII. If untreated, simple *nævi* may persist unchanged, or may disappear, in a few instances they increase rapidly in size, either early or late in life, sometimes giving rise to a considerable vascular growth, purplish in colour, and occasionally becoming prominent and pendulous. Such a tumour is soft and easily compressible, being in reality a cavernous angioma, it may ulcerate, and profuse hæmorrhage may result. *Treatment* consists in electrolysis, if excision is impracticable.

The **Cavernous Nævus** consists of dilated spaces, where the tubular form of the constituent vessels is lost, the arteries usually opening directly into thin walled cavities lined with endothelium without the intervention of capillaries (Fig 46). The tumours are thus more or less erectile in nature, somewhat resembling the corpus

**cavernosum** They are met with in the skin and subcutaneous tissues, constituting diffuse or circumscribed tumours of a reddish-blue colour, which can be emptied on pressure, but rapidly refill when such is removed, and in which pulsation is occasionally present. A similar condition arises in the viscera, especially the liver, and then is always acquired, and it is not difficult in suitable cases to demonstrate that it has been formed by a dilatation of the capillaries between the lobules, the liver substance meanwhile disappearing by a process of simple atrophy. Occasionally a cavernous angioma undergoes spontaneous cure as the result of some inflammatory affection similar in nature to phlebitis, a non-vascular fibro cystic mass remaining.

Under the term **Plexiform Angioma** may be included the cirroid aneurism, or aneurism by anastomosis, the former term being applied by some authors to tumours consisting of large vessels, and then most commonly seen about the scalp and face, and the latter to a congeries of small vessels. The treatment is always a matter of considerable difficulty (see Chapters XX and XXV).

**Lymphadenoma and Lymphangioma** — The primary tumours developing in connection with lymphatic glands and vessels are described in Chapter XIV.

**Odontoma** — Tumours originating from some abnormal condition of the teeth or teeth-germs are known as 'odontomes'. Bland Sutton, in his work on tumours,<sup>\*</sup> has described seven different varieties, several of which are, however, rarely met with in man. We can only deal here with the more important of these and must refer our readers to Chapter XXVII and to Sutton's book for a fuller description. (1) **Epithelial Odontome** — In this condition, formerly known as 'fibro cystic disease of the jaw,' the mandible is most commonly affected. A tumour forms, consisting of spaces lined by epithelium, which are developed as irregular outgrowths from the enamel organ. It occurs most frequently in young people, and may give rise to a growth of enormous size. (2) **Follicular Odontomes**, or, as they are often termed, 'dentigerous cysts,' are produced by the development of a cavity around a misplaced or ill-developed tooth of the permanent set, which often lies horizontally, so that its eruption is impossible. (3) **Fibrous Odontomes** are the result of a thickening and condensation of the connective tissue around a tooth sac. They are most frequently observed in the lower animals, but are also said to occur in rickety children. (4) **Radicular Odontome** is the term applied to a tumour composed of cement, developing at the root of a tooth. It gives rise to severe pain, and may result in septic inflammation of the surrounding bone. (5) **Composite Odontomata** consist of a conglomeration of the various forms of tissue entering into the formation of a tooth, and developing in the neighbourhood of the jaw. They may be very large, and

\* Bland Sutton, Tumours and Cysts. Cassell and Co.

probably some of the bony tumours described as osteomata of the antrum are of this nature

## II Tumours of Epithelial Origin

The various tumours grouped under this heading are composed mainly of epithelium, with a variable admixture of connective tissue. They are derived from pre-existing epithelial structures, and vary in the arrangement and character of the epithelium with the site of origin. Epithelial cells can practically be of only three types—(a) The spheroidal or cuboidal, in which the three diameters are more or less equal, (b) the flat or squamous, in which two diameters are long and one very short, and (c) the columnar, in which one diameter is long and two are short. These three forms of cells are found in most of the groups of epithelial tumours. In some the structure conforms more or less to the normal type, and then the growth is probably of an innocent nature, as in the papillomata and adenomata, but when the structure becomes atypical, the tumour is likely to be malignant and of a cancerous nature.

**Papilloma**—This term ought really to be limited to tumours formed by an overgrowth of papillæ, and since papillæ are confined to regions covered with epithelium of epiblastic origin, they are, strictly speaking, only found in the skin and the so-called 'mucous membranes' which are morphologically of the same nature—*i.e.*, that lining the mouth, vagina, larynx, anus, etc. They consist of the same structures as a normal papilla, there being a central core of mesoblastic tissue (connective tissues, vessels, etc.) covered by squamous epithelium, which may or may not undergo excessive horny development, and, like the normal papillæ, of which they are an exaggeration, they project outwards from the general surface of the body, and never invade the subcutaneous or submucous tissues.

The term is, however, often used loosely to indicate a growth composed of a mesoblastic core with an investment of epithelium, whatever its origin, thus, we speak of papillomata of the large intestine, although in this region papillæ do not occur. Hence it becomes convenient to classify the papillomata according to the nature of the epithelium with which they are covered, since this is readily recognised microscopically, and affords a clue to their place of origin.

(1) Those covered by *squamous* epithelium occur in the skin, mouth, larynx, etc., and consist of bundles of papillæ, which undergo extensive proliferation and frequently branch, forming secondary papillæ. If the epithelium undergoes keratinization, as in the common warts, they become hard, and may constitute horn-like outgrowths. When they occur in moist situations, *e.g.*, between the toes, on the prepuce, or growing from mucous membranes (except that covering the vocal cords), this formation of horny substance is usually very imperfect, and the papillomata remain soft. It must be pointed out that many of the squamous papillomata are of infective origin, and not true tumours at all—*e.g.*, the venereal warts, condylomata, and mucous tubercles. There are

some reasons for thinking that warts may be infective and due to the action of a micro-organism. Not unfrequently a papilloma which has become irritated may take on malignant action and be transformed into an epithelioma, a change which would be characterized clinically by the base becoming infiltrated.

The papillomata which develop in the bladder and pelvis of the kidney are covered by many-layered *transitional* epithelium, and usually form long delicate fimbriated tufts containing delicate

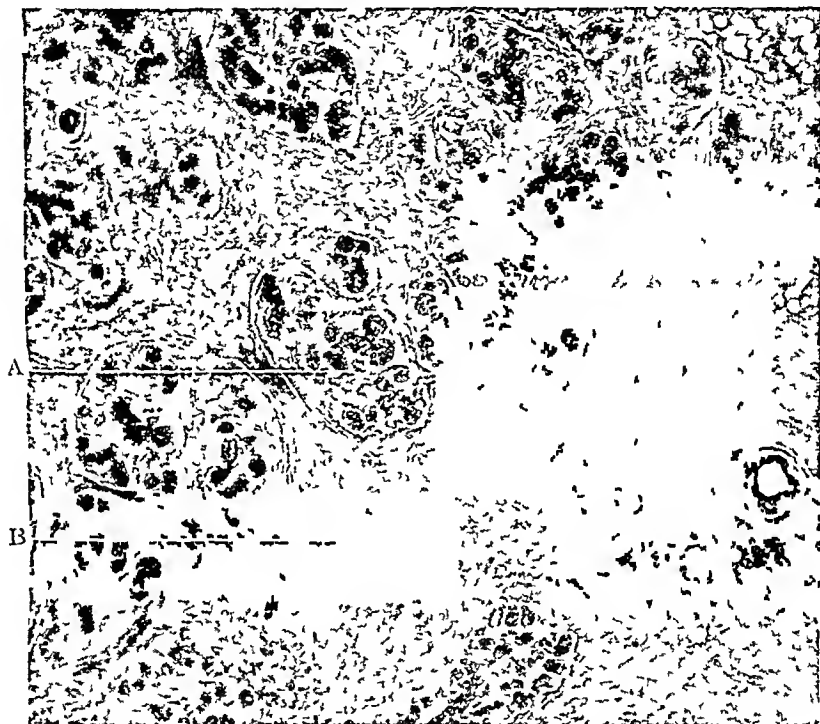


FIG 47 — FIBRO ADENOMA OF BREAST (PHOTOMICROGRAPH)

A, Newly-formed glandular tissue B fibrous stroma

bloodvessels, which readily give way and may lead to considerable hæmorrhage. Portions are often torn off and escape in the urine where they are easily recognised. They often occur in conjunction with malignant growths.

(2) Papillomata covered by *cuboidal* or *spherical* epithelium occur in glandular structures, especially in cystic adenomata of the breast, kidney, etc.

(3) Papillomata covered by *columnar* epithelium are sometimes found projecting into cystic cavities in other tumours, as in the proliferous ovarian cysts and in duct carcinoma of the breast, as also into dilatations of other ducts. The 'papillomata' of the intestine are usually either adenomata or fibromata.

**Adenomata** consist of new growths arising in connection with secreting glands, and in structure simulating somewhat closely the organs from which they rise (Fig 47). They differ from them, however, in that they are incapable of producing the characteristic secretion, that they are devoid of ducts, and that the mimicry is incomplete, since the alveoli are less perfectly developed, and may be entirely occupied by several layers of epithelial cells. The epithelium, which from the nature of the case is spheroidal, cuboidal, or columnar in shape, does not pass beyond the basement membrane into the connective tissue, and by this lack of infiltration they are distinguished from cancerous tumours. A variable amount of connective tissue is always present, and may be normal in texture, or may manifest various modifications. Adenomata are usually encapsuled, being merely connected with the original gland by a pedicle, through which the vessels enter. When growing from mucous membranes, they are sometimes pedunculated, as in the so called polypus recti. The alveoli in some cases become distended with effusion, giving rise to a cysto adenoma or adenocoele. They are absolutely free from malignancy, except when, as occasionally happens, the connective tissue undergoes a sarcomatous change, whilst sometimes carcinoma supervenes. When of large size, they may cause trouble by compression of important structures. Any glandular organ may become affected with adenoma, and several varieties will be described hereafter in the chapters on the breast, thyroid body, prostate, testis, etc. They are also found as congenital tumours in connection with the thyroid body, postanal gut, and possibly the kidney. The growth is usually slow, but occasionally becomes rapid.

**Carcinoma** --The malignant forms of epithelial new growth are known as cancers or carcinomata, of which the following varieties are described, viz., epithelioma, columnar carcinoma, and glandular or acinous cancer, according to whether the epithelium from which the tumour is derived is of the squamous, columnar, or spheroidal type. The term 'colloid cancer' is also used to indicate a degenerative change occurring in some forms.

The essential character of a cancerous growth consists in an unlimited multiplication of the epithelial elements of the organ or tissue attacked. In some cases this may result in the formation of a superficial outgrowth of a papillomatous type, while deep processes or columns of cells advance into the tissues along the lymphatic channels, and even burst through the basement membrane of glandular alveoli. The irritation of this development leads to an infiltration of the surrounding structures with round cells, which are presumably inflammatory in origin, by the agency of which the normal tissues are disintegrated and removed, and a stroma of variable density develops around the epithelial outgrowths. Hence all cancerous tumours may be said to consist of a fibro-cellular or fibro-cicatrical stroma (Fig 51), within the alveoli of which are collections of epithelial cells, sometimes arranged in a

methodical manner, but more often packed irregularly together, and with no intercellular tissue between them. The alveolar spaces are in reality dilated lymphatics, and hence it is easy to understand that carcinomata are disseminated along these vessels. The cancer cells are epithelial in origin, and of very variable size and shape, but they always retain more or less the characters of the epithelium from which they are originally developed, thus, a squamous epithelioma is never derived from a part covered with columnar epithelium, or *vice versa*. Bloodvessels ramify through the stroma, and are more or less abundant according to its density. The tumours are not necessarily tender to the touch, but a considerable degree of pain, usually of a neuralgic type, is often complained of, especially in the harder forms, where tissues get dragged upon by the contracting stroma.

Epithelioma (syn. Squamous Epithelioma, Epithelial Cancer)

By this term is meant a cancerous tumour growing from skin or from those portions of the mucous membranes which are covered with squamous epithelium.

Epithelioma is usually met with in middle-aged or elderly individuals, although occasionally it is seen in young adult life. Any portion of the skin may be the site of this tumour, as also the mucous membrane of the mouth, pharynx and œsophagus, and that lining the genito-urinary tract. It commonly results from some long-continued irritation, as in the lip or tongue, whilst upon the penis it is always associated with a long foreskin. Old scars, especially if they become ulcerated, are likely to be invaded, and the disease may supervene on intractable lupus.

*Clinically*, epithelioma may be looked upon as a malignant wart, which not only grows outwards from the surface, but also burrows deeply into adjacent tissues, sooner or later ulceration follows. Several characteristic forms are described. (a) It may occur as a nodular indurated mass, with hard everted edges and central ulceration, giving rise to a somewhat crateriform ulcer (Fig 48). (b) The destructive process may extend equally with the new formation, leading to the appearance of a depressed sore, with sharply-cut edges,



FIG 48 — TYPICAL EPITHELIOMATOUS ULCER SHOWING HEAPED UP MARGINS AND DEEP CENTRAL CRATERIFORM EXCAVATION. (COLLEGE OF SURGEONS MUSEUM)



closely resembling a rodent ulcer (c) Occasionally the superficial outgrowth is excessive, and the destructive process limited, giving rise to a projecting cauliflower-like mass, which is soft and easily bleeds (*malignant papilloma*) (d) A chronic epithelioma is sometimes seen, in which the fibrous stroma contracts and compresses the

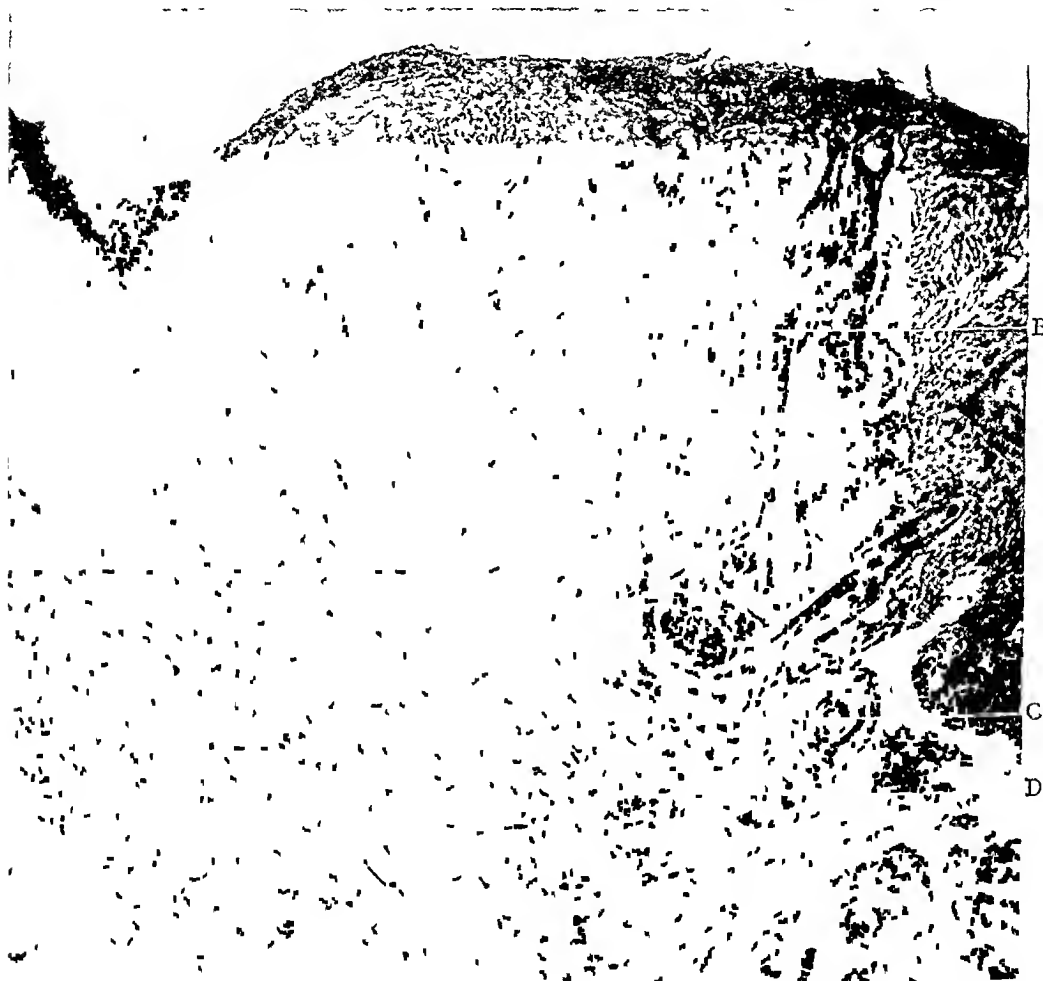


FIG 49—EPITHELIOMA OF LIP

The epithelium at the left-hand margin of the figure is normal, whilst at A the altered appearance of the cells appears to indicate that they have become malignant at B, C D they are growing down into the stroma in irregular columns B indicates a small cell-nest and C passes through one half an inch from its extremity The connective tissue stroma is inflamed This is most marked at F

columns of epithelial cells, the surface is then indurated and wart-like, with but little ulceration, whilst the base is very hard, and the progress of the case much less rapid than in other forms This form is not uncommon in the lip (Fig 295)

The disease, as a rule, early infects neighbouring lymphatic glands, which become the seat of a similar growth, and, if superficial, sooner or later involve the skin and give rise to characteristic ulceration. As the disease progresses, more distant groups of lymphatic glands are attacked, it is unusual to find this form of cancer disseminated through the internal viscera. The glands sometimes become cystic, especially in the neck, and on cutting into them a thin, turbid fluid like sero-pus escapes, mixed, perhaps, with masses of epithelial debris, from time to time similar material is discharged through the resulting sinuses. Ulceration into the main vessels of the neck may also follow, and cause death from hæmorrhage, otherwise the fatal event is due to cachexia and exhaustion.

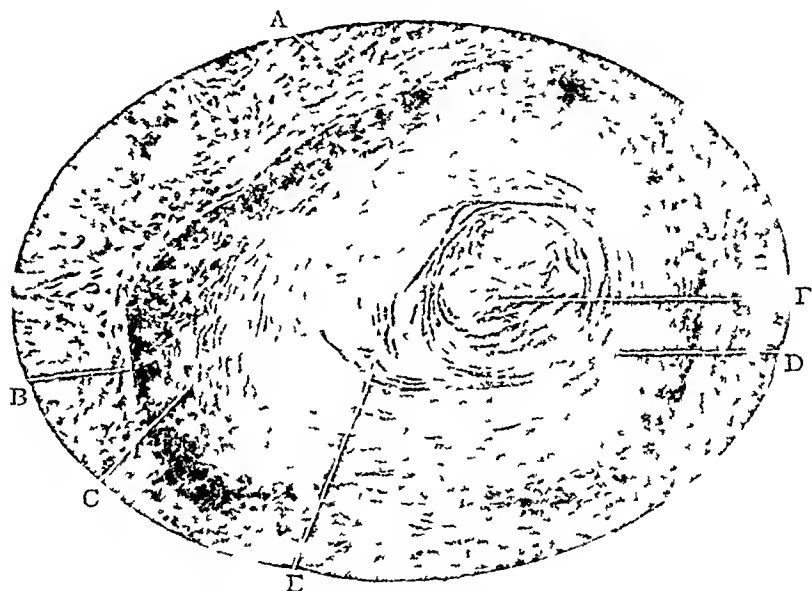


FIG. 50.—EPITHELIAL CELL-NEST, FROM AN EPITHELIOMA OF THE MOUTH

A, Stroma, with collections of small round cells, B layer of basal epithelial cells, C, prickle cells which at D have become flattened, E and F show the final stage, the cells being transformed into badly-formed keratinous scales.

*Microscopically*, an epithelioma consists of club-shaped columns of epithelial cells (Fig 49), ramifying in the subcutaneous tissues, and interlacing freely with each other, so as to produce an irregular network, the meshes of which are occupied by a fibro cellular stroma, which is frequently infiltrated by an inflammatory exudate of small round cells (largely lymphocytes or plasma cells). The parenchymatous or true cancer cells are derived from the prickle-cell layer of the epidermis, and in most cases their nature can be readily made out. In some rapidly-growing very malignant cases, however, the cells undergo so much alteration that the prickles are difficult to find. The cells in contact with the stroma are usually regular, and resemble the basal layer of normal skin, the cells above this are

polygonal in shape, and in the outer layers may become flattened and undergo imperfect keratinization. This is best seen in the cell nests (Fig 50) which develop in the substance of the columns, and in these the different layers can be readily traced.

**Glandular or Acinous Cancer**—Glandular cancer may be looked on as a *malignant* form of *adenoma*, bearing the same relation to the latter as does an epithelioma to a benign papilloma. The epithelium of the glandular acini, from which it originates, is not retained by

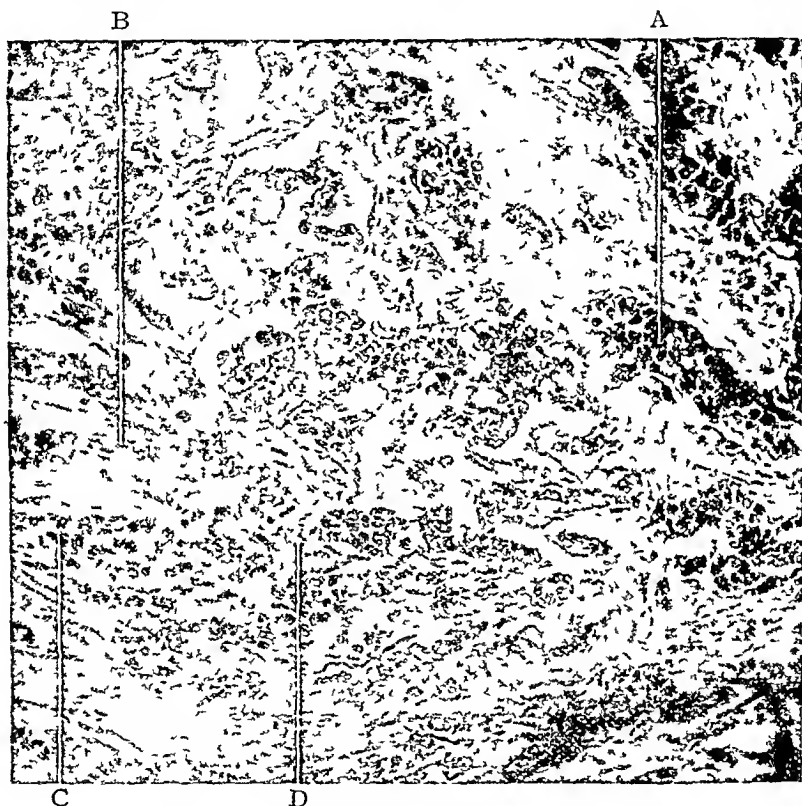


FIG 51 —CARCINOMA (SCIRRHUS MAMMÆ)

A is an alveolus of epithelial cells, B, a column of similar cells infiltrating the connective tissue. C is also a fine column of growth which has shrunk away from the stroma so that the endothelial lining of the space is apparent, the presence of this endothelium shows that the space now filled by cancer cells was originally a lymphatic vessel or space. D is a large epithelial cell with a single nucleus (parenchymatous giant cell).

the basement membrane, but travels beyond it along the lymphatics into surrounding parts, which are transformed into the tumour substance by a process already described. The amount of stroma varies considerably, and according to whether it is abundant or small in quantity, the tumour is hard or soft in consistence, and slow or rapid in growth. To the former type the term *Scirrhus* is applied, to the latter, *Encephaloid*.

Scirrhus is met with most frequently in the breast, but also occurs in the prostate, pancreas, and pyloric end of the stomach. The clinical features of the disease as seen in the breast are described in Chapter XXXIII. On naked-eye examination a scirrhus tumour appears as a hard nodular mass, the limits of which are imperfectly defined. When cut across, it creaks under the knife, and presents a yellowish-white surface, which rapidly becomes concave owing to the contraction of the fibrous stroma. It has often been compared to the section of an unripe pear or turnip, both on account of the grating sensation imparted to the knife and from its appearance. On scraping the cut surface with the blade of a knife, a typical cancer juice is obtained, consisting of epithelial cells and débris.

On microscopical examination, the tumour is found to consist of an abundant and well-marked stroma, the acini of which are filled with epithelial cells (Fig 51). In the centre fatty degeneration is often present, small cysts being occasionally produced in this way. At the periphery the growth may be seen extending in all directions along the lymphatics, whilst a round-celled infiltration of the surrounding tissues is also evident.

Where the stroma is very excessive, the cell elements, and, indeed, the whole tumour, may undergo atrophy, owing to compression of the nutrient vessels, constituting the variety known as *atrophic scirrhus*.

**Encephaloid, Medullary, or Acute Cancer**, is the term given to a growth of a similar nature, in which the stroma is much less abundant than the cell elements. It constitutes a rapidly-growing tumour, not so hard as a scirrhus, abundantly supplied with bloodvessels, and very early infiltrating surrounding parts and affecting neighbouring lymphatic glands. The skin over such a tumour is stretched, and dilated blue veins can be seen through it. Ulceration occurs early, and from this surface a foul, bleeding, fungating mass sprouts up, formerly known as a 'fungus hæmatodes'. Encephaloid cancer is met with in the breast, testis, kidney, and a few other glandular organs.

On section it is found to be composed of a soft whitish mass, somewhat resembling brain substance. It is usually very vascular, perhaps pulsating, and hæmorrhagic extravasation into its tissues is not uncommon. An abundant juice is obtained on scraping. Under the microscope large groups of spheroidal epithelial cells are seen, held together by a scanty stroma.

**Columnar Carcinoma** — This affection, which was formerly termed 'columnar epithelioma,' is in the majority of cases a true glandular cancer. It is met with most frequently in the alimentary canal, arising from any portion of it in which columnar epithelium occurs, and usually originating as an overgrowth of Lieberkuhn's follicles (Fig 53). These form a projecting growth from the surface in the same way as a papilloma springs from the skin, but also penetrate deeply into the submucous and muscular coats. The deep processes retain an imperfect alveolar arrangement, and between them

is found a certain amount of fibro cellular stroma, upon the character of which the hardness of the tumour depends. In the firmer types the stroma is abundant, and fibro-cicatrical in quality, the growth of the tumour being slow, in the softer and more rapidly-growing forms the stroma is less abundant, and more of a simple fibro-cellular nature. On section of a limited portion of the growth, it is usually possible to distinguish it from a simple adenoma of Lieberkuhn's follicles, since in the latter the alveoli are complete and regularly lined with a layer of columnar epithelium, whilst in cancer the alveoli



FIG 52 — COLUMNAR CELLED CARCINOMA OF RECTUM

A is a normal gland, the regular construction of which is in marked contrast to the irregular formation of the malignant gland B. The latter contains mucus, broken down cells and leucocytes, C, whereas the normal glands are practically empty. D is a mass of small round cells in the stroma.

vary in shape and the epithelial elements are much less regularly arranged. The distinction is well seen in Fig 52. If a large section, including the whole thickness of the intestinal wall, is examined, the extension of the glandular tissue into and between the muscular fasciculi (Fig 53) at once indicates the malignant nature of the case. Ulceration usually occurs, giving rise to a typical sore, bounded in

the more chronic forms by indurated and everted edges. Neighbouring lymphatics are implicated, as in the case of all cancers, whilst later on the disease spreads to the viscera, and may be generally disseminated. A similar type of growth occurs in the cervical portion of the uterus, and occasionally in the ducts of glands such as the liver and breast. It is also met with in the superior maxilla, originating in the tubular glands of the mucous membrane lining the antrum.

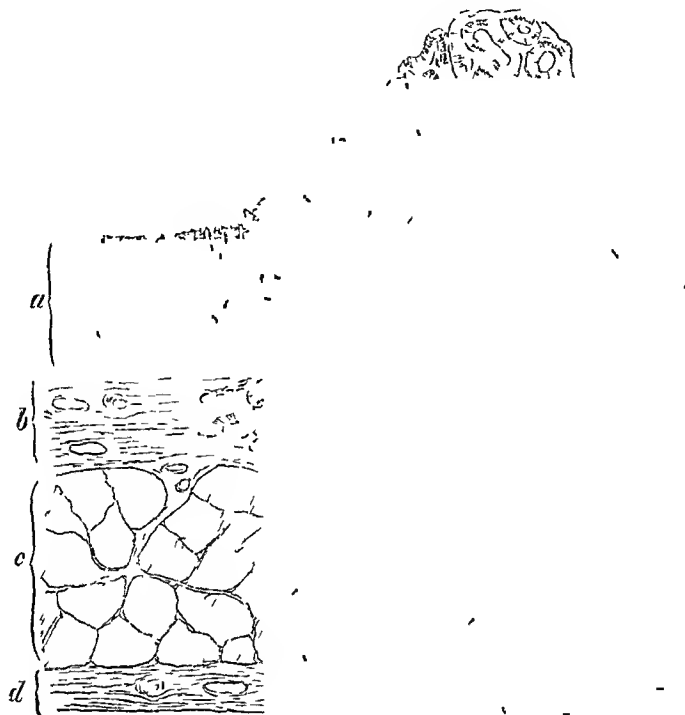


FIG 53 —SECTION THROUGH ADVANCING MARGIN OF COLUMNAR CANCER OF STOMACH  $\times 25$  (ZIEGLER)

*a* Mucosa *b* submucosa *c* muscularis *d* serosa, *e* neoplasm which, starting from the mucosa, has invaded the other layers. Small celled infiltration has accompanied here and there the formation of the neoplastic tubules.

**Colloid Cancer** results from a degeneration of the epithelial cells of a glandular or columnar cancer. Its most frequent site is within the abdominal cavity, in connection with cancers arising from the stomach, intestine, or omentum.

To the naked eye colloid cancer presents an alveolar texture, the spaces being filled with translucent gelatinous material of varying density. Microscopically, the epithelial cells are rarely distinguishable, being replaced by a structureless colloid substance. Towards the growing margin, however, the cells may be seen in process of degeneration, globules of the material forming within them and pressing the nucleus to one side.

The Treatment of Cancer consists in the removal of the tumour by operation, together with a wide margin of healthy tissue around it, or, in some cases, of the whole organ affected, as well as the lymphatic area concerned, and, if practicable, in one mass, so as not to cut across the lymphatic vessels passing from the growth to the glands. If such is conducted in a thorough manner and at a sufficiently early date, a good result may be anticipated, but, owing to the tendency of all cancers to spread along lymphatics, its eradication is usually a matter of the greatest difficulty. Recurrence is therefore very liable to ensue.

In cases where removal of the disease by the knife is impracticable, owing to its extent, it may sometimes be possible to remove a portion of the disease, the remainder being dealt with by caustics. Of these the most satisfactory is chloride of zinc, which is usually applied as a paste, a little opium being added to allay pain. In other instances it has been proposed to starve the growth by tying the chief nutrient artery, and to diminish pain by division of sensory nerves, such can, however, only give the most temporary relief.

Of recent years other methods have been suggested for the treatment of inoperable malignant disease, *e.g.*, the interstitial injection of pyoktanin or methyl violet, or of various bacterial products, such as Coley's fluid (p. 185). The evidence at present forthcoming suggests that the practical value of these proceedings is very small.

Somewhat more hopeful results have been obtained by the use of the X rays. The effect of exposure to this agent is to set up a localized leucocytosis, and this results in the breaking down of the neoplastic tissue and its replacement in favourable cases by fibrous tissue. The whole subject is still in the experimental stage, but our present experience seems to indicate that early recurrences in the skin of the cuirasse type, ulcerating and fungating masses, and some forms of sarcoma, benefit most from this procedure. In the case of epitheliomata the results have been most discouraging, whilst deep-seated foci of disease are practically uninfluenced.

The application of the rays should always be in the hands of skilled radiographers, as serious and extremely chronic burns may result from injudiciously prolonged sittings, and the mischief done may not become evident until twelve or fourteen days after the particular application. Surrounding parts must be carefully guarded by lead foil or by the use of a 'shielded' tube which only allows the rays to act on the required area. Modern improvements in the direction of accurately measuring the quantity and quality of the rays will certainly allow this method of treatment to be used more scientifically.

High-frequency currents have been extensively used in this direction, but *per se* have no influence on the disease, although they may improve the general health by their tonic effect. The recently introduced 'high vacuum electrodes' give off a small quantity of X rays, and may enable one to apply these rays to cavities or in situations which would be otherwise inaccessible.

In hopeless cases all that can be done is to keep any ulcerated surface free from irritation and, if possible, aseptic, whilst the general

health is maintained by suitable diet and drugs, and pain is kept in check by morphia or opium

**Rodent Ulcer** is a special variety of glandular cancer, commencing either in the sebaceous glands or in the basal layer of the rete Malpighii. It is usually met with in elderly patients, though occasionally observed in those under forty, and is seen with special frequency on the upper two-thirds of the face, the skin below the inner and outer canthi being the chief seats of election. It commences as a papule or flat-topped nodule in the skin, surrounded, perhaps, by an area of hyperæmia. The infiltration extends gradually in all directions, but the ulceration usually keeps pace with the new growth. The ulcer has a smooth but somewhat depressed surface, is perhaps covered with granulations, and bounded by a slightly-raised, indurated, rolled over edge (Fig 54). In the later stages one can often detect evidences of the new formation beneath the skin beyond the edge. If kept aseptic, there is but little discharge, and imperfect attempts at cicatrization are



FIG 54 —RODENT ULCER (FROM A PHOTOGRAPH)

often observed, the scar, however, readily breaking down, but when septic, the surface is covered with sloughs, and an abundant offensive discharge escapes. The condition is painless, neighbouring lymphatics are not enlarged, and the general health does not suffer, except in the later stages. The progress of the case is slow, but continuous, and although it spreads superficially rather than deeply, sooner or later underlying structures become involved, and nothing hinders the destructive process, even the bones of the skull being eroded, and the dura mater exposed.

*Microscopically*, the growth is very similar to an epithelioma, consisting of interlacing columns of epithelial cells, interspersed



with fibro-cellular tissue (Fig 55) The chief differences consist in the facts—(i) that the constituent cells, although epithelial, are not epidermic in character, being smaller, more globular, never of the 'prickle-cell' type, and rarely showing signs of keratinization, hence, 'cell-nests' are uncommon, although they are sometimes observed (ii) The deep processes are not so distinctly columnar or club-shaped, spreading laterally beneath the unaffected skin



FIG 55 —RODENT ULCER OF EYELID

A Normal epithelium, B, alveoli of growth At C the skin is thinned out by the pressure of the underlying growth, from which it is quite distinct

rather than deeply, their outline is also more clearly defined, and frequently angular on section (iii) There is less cell infiltration around the new formation

The Treatment of rodent ulcer has been considerably modified of late Formerly the method of choice consisted in free excision when practicable, a margin of *at least* half an inch being allowed all round, and the defect made good by skin-grafting or by some plastic operation Where such could not be undertaken, the ulcer was thoroughly scraped, and the surface treated with nitric acid, chloride of zinc paste, or some other caustic, the wound being allowed to heal by granulation

The discovery of the therapeutic value of the X rays has considerably diminished the number of cases operated on for this disease. The sore or nodule is exposed to the influence of the rays for about ten minutes daily, and a reaction of variable intensity follows, which results in many cases in the surface of the sore cleaning up and healing. Recurrence is occasionally observed, but the recurrent nodules can be treated in the same way. Of course, surrounding parts have to be carefully protected.

Radium bromide has also proved serviceable in some cases. It is best applied in a lead capsule with a mica window, and 5 or 10 milligrammes is the usual quantity employed. This capsule is enclosed in a piece of sterilized gutta-percha tissue and fixed over the diseased area with strapping. It may be applied for a short time (five or ten minutes) daily, but acts equally well if applied for half an hour once a week. The reaction varies considerably with the quality of the radium, but sometimes an inflammatory reaction of some intensity follows.

Our present experience seems to indicate that small nodular growths or ulcers react well to radium or the X rays, but the former is perhaps preferable. Larger sores are dealt with by excision if possible, and if the patient's appearance is not likely to be seriously affected by the extent of the proceeding. The scar left after treatment by the rays is of a most satisfactory type, being soft, supple, and often not at all obvious, and hence this treatment is particularly indicated when the disease affects the eyelids or front of the face. In other places it may be possible to remove the greater part of the disease with the knife, and the rays may then be used with advantage to the raw surface before grafting is undertaken. When bone or cartilage is affected, operation is the only hope, as although improvement follows the use of the rays, recurrence is almost invariably the rule.

### III Tumours of Endothelial Origin

The *Endotheliomata* form a large and important group of tumours. They are by no means rare, and as a class are much less malignant than the sarcomata or carcinomata, to which they often have a close structural resemblance, they often recur locally after removal, but it is unusual for them to affect glands or form secondary deposits in internal organs. Their most frequent seat is in the parotid gland, where they form the *mixed parotid tumour* of the older surgeons, but they are common in other parts in the neighbourhood of the mouth and in the meninges of the brain and cord, they may occur, however, in any part of the body. The cells constituting an endothelioma are derived from the pre-existing endothelium of the region, and they become spherical, cuboidal, or even columnar in shape, and take on independent growth. The tumour may start in the lymphatic clefts, which then appear to be injected with cuboidal cells, and form a cellular network having a general resemblance to a carcinoma. The

stroma between these columns is profoundly altered, usually becoming mucoid or converted into a hyaline tissue resembling cartilage, fat is often deposited in it, and cystic degeneration may take place, the tumour thus formed being of extraordinary complexity. In other cases the cells affected are those lining the smaller lymphatic vessels, and in some cases this may especially involve those occurring in the vascular sheaths, forming a cellular investment to the smaller

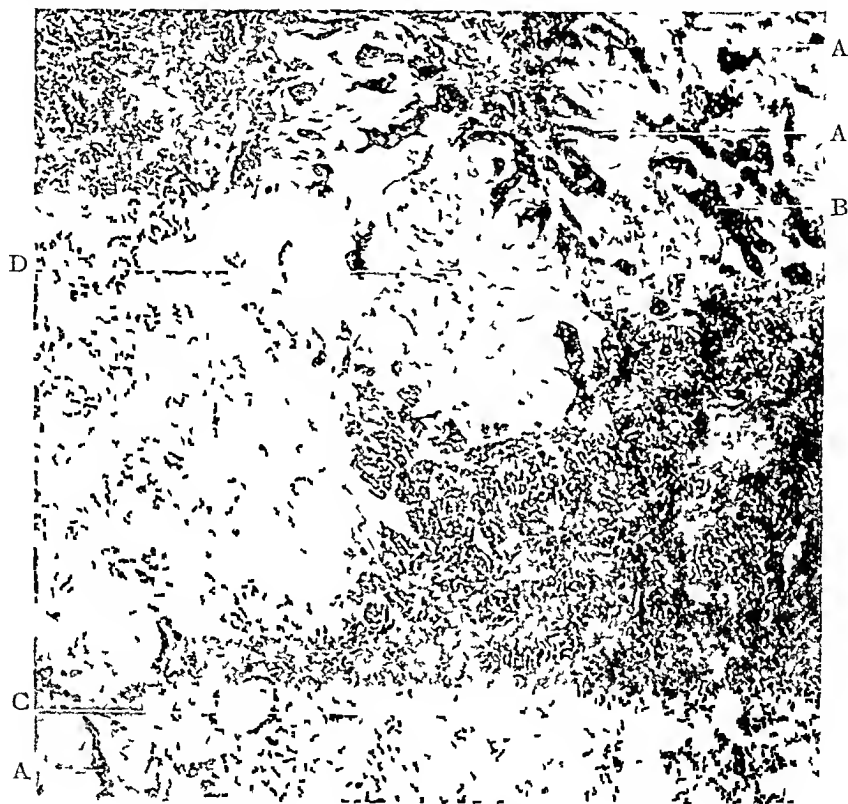


FIG 56 —ENDOTHELIOMA OF THE PAROTID GLAND

A, Strands of endothelial cells lying in lymphatic clefts and forming a kind of natural injection of those structures, B is a similar strand, but the cells have continued to grow and the strand is many cells thick. At C there are alveoli of endothelial cells less closely packed. D is the cartilage like stroma common in these tumours.

vessels (perithelioma or perithelial sarcoma). In a third group the endothelium which takes on morbid growth is that which lines the bloodvessels themselves. In this case it is common for the cylinders of cells thus formed to undergo a hyaline degeneration (cylindroma).

The endotheliomata which occur in the brain are usually composed of spindle-shaped cells, which have a tendency to organize into fibrous tissue, and have a curious arrangement in whorls, something like those of a cell-nest. The central portions of these masses

frequently undergo conversion into a material resembling amyloid substance, and subsequently become calcified. These tumours are called **Psammodata**. They are amongst the commonest new growths met with in the brain, and are usually superficial, are readily shelled out, and do not tend to recur after operation.

#### IV Tumours formed by Inclusion of Part of another Embryo

**Teratomata** are tumours derived from included embryos, or from portions of a second embryo, which are formed by dichotomy, but which have remained rudimentary and partially or completely buried in the tissues of the host. The commonest example is the so-called *dermoid of the ovary*, which is sometimes a complex tumour, and differs from the simple dermoid cysts (formed by inclusion of a piece of skin shut off from the surface in the process of development) in that it contains structures such as bone, muscle, gland tissue, etc., which are formed from all three layers of the embryo. In some rare cases the tumour is more complex still, larger portions of an embryo (such as a limb) being recognisable. Similar dermoids are found in the testis and in other portions of the body, though only in rare cases. Teratomata of complex structure are often found in the sacral region, where they are probably due to posterior dichotomy, the smaller portion of the embryo remaining rudimentary and attached to the larger twin in the region of the sacrum.

#### Cysts

By a cyst is usually meant a more or less rounded cavity, with a distinct lining membrane, distended with some fluid or semi-solid material. The term is used very loosely, being applied to a variety of manifestations which it is difficult to classify, owing to the fact that conditions which are pathologically similar in origin are sometimes termed cysts in one part of the body, and not so in another. For practical purposes, however, they may be grouped as follows:

I Cysts of *embryonic origin*, or arising in connection with embryonic remains

II Cysts arising from the *distension of pre-existing spaces* (distension cysts)

III Cysts of *new formation*

IV Cysts of *degeneration*

#### I Cysts of Embryonic Origin, or arising in Connection with Embryonic Remains

1 The most important cysts to be considered under this heading are those known as **Dermoids**. These are characterized by the existence in abnormal situations of cavities lined with epithelium, from which may be developed such forms of cutaneous appendages as hairs and nails, whilst the space is usually occupied by sebaceous

contents The structure of the lining wall is very similar in nature to skin or mucous membrane, consisting of stratified epithelium, from which a considerable growth of sebaceous glands and hair follicles often takes place. If teeth or more complex tissues, such as bony alveoli, mammary glands, nipples, etc., are enclosed in such a cavity, it should probably be looked on as a teratoma.

Several varieties of dermoids are described.

(a) **Sequestration Dermoids** are cysts arising from the incomplete disappearance of surface epithelium in situations where, during

embryonic life, fleshy segments coalesce. Thus, in almost any part of the middle line of the body such tumours may develop, owing to the fact that there is here a union of two lateral segments. Similarly, they are not uncommon about the face and neck, occurring along the lines of the facial and branchial clefts. Perhaps the most common position for them in this region is the upper portion of the orbito-nasal cleft, behind and to the outer side of the eye (Fig. 57). It is not unusual to find the skull defective beneath them, and a pedicle extending from the deep side, connecting them with the dura mater. Sequestration dermoids appear as rounded, definitely limited tumours, over which the skin glides freely, but are usually somewhat adherent



FIG. 57—DERMOID CYST GROWING AT THE OUTER ANGLE OF THE ORBIT (BLAND SUTTON)

to the deeper parts. They are firm and elastic to the touch, and filled with sebaceous material, containing fatty debris, flattened epithelial cells, perhaps hairs, and occasionally teeth. This form of dermoid may be removed without difficulty, but in those occurring about the scalp, with the bone hollowed out beneath them, it is perhaps advisable to delay operation till adult life, unless the tumours are rapidly increasing in size. The reason for this is that the bone gradually grows up around the pedicle, and thus closes the communication with the cranial cavity. In some cases it may be difficult to remove the whole of the lining membrane by dissection, and under these circumstances the portion left behind should be destroyed with cautery or caustics; otherwise, recurrence is almost certain to follow.

(b) Dermoids may also arise in connection with embryonic canals and passages, and have then been called **Tubulo-Dermoids**. These are chiefly met with in connection with the thyroglossal duct (Chapter XXXI) and the post-anal gut (Chapter XXIV).

(c) **Ovarian Dermoids** are usually unilocular, and often of large size. They are lined with skin, from which an abundant development of cutaneous appendages is sometimes observed. Thus, the cavity may be more or less filled with hair, whilst large masses of teeth set in bony alveoli are also seen in this situation, and even nipples and mammae. We have already explained that probably all of these growths are to be looked on as teratomata.

2 **Cysts** occasionally arise in connection with the formation of the teeth, such have been already alluded to under the terms follicular and epithelial odontomes (p 199), the former being also known as dentigerous cysts, the latter as fibro-cystic disease of the jaw.

3 Various cysts develop in connection with the remains of the *Wolffian body*, as also from its tubules and duct. It must be remem-

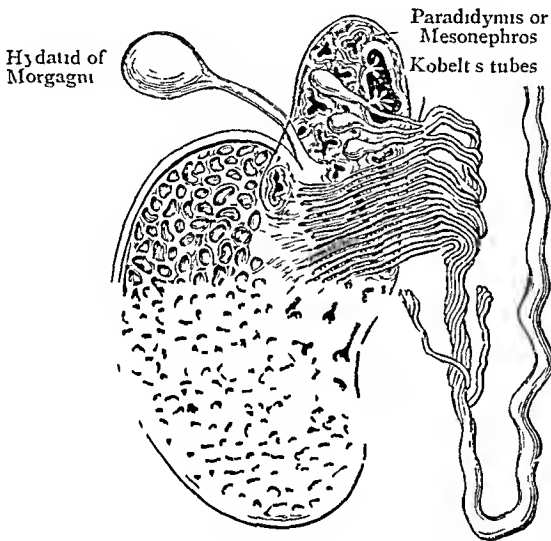


FIG 58 —DIAGRAM OF ADULT TESTICLE TO SHOW RELATION OF MESONEPHROS AND ITS DUCTS (BLAND SUTTON)

bered that this body arises in the posterior abdominal wall near to the origin of the kidney and testis, and that part of it enters into the formation of the latter, hence one is not surprised to find that its remains are closely associated with that organ in the scrotum.

In the male (Fig 58) the Wolffian body atrophies almost completely, being represented by a few blind tubules, situated close to the epididymis, and known as the paradidymis, or organ of Giralde's. Fibro-cystic disease of the testis (adenoma testis) is said to arise from this structure. The majority of the ducts of the Wolffian body form the vasa efferentia testis, a few of the upper ones, however, contract no attachment to the gland, and their free ends (known as Kobelt's tubes) may become dilated, and form small cysts, situated close to the hydatid of Morgagni, which structure represents the remains of the Mullerian body and duct. It is

possible that an encysted hydrocele of the epididymis sometimes arises from one of these unobliterated tubules. The main duct of the Wolffian body forms the lower portions of the epididymis and vas deferens.

In the female (Fig. 59) the remains of the Wolffian body are sometimes met with as a series of closed tubes in the neighbourhood of the ovary (paroophoron). Cysts may arise in connection with this structure, and are chiefly characterized by their inner walls being the seat of proliferating papillomata. The Wolffian tubules can almost always be recognised in the broad ligament, constituting the paroovarium, or organ of Rosenmüller. **Paroovarian Cysts** formed from the distension of this structure are usually unilocular, and filled with a clear limpid serous fluid, they have no definite pedicle, and strip up the layers of the broad ligament.

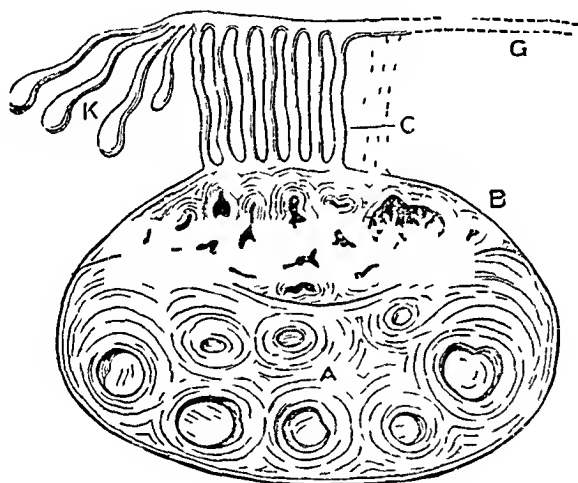


FIG. 59.—DIAGRAM TO REPRESENT THE CYST REGIONS OF THE OVARY  
(BLAND SUTTON)

A, Oophoron, or ovarian tissue. B, paroophoron, or tissue of the hilus. C, paroovarium. K, Kobelt's tubes. G, Gartner's duct (=main Wolffian duct).

Some of the terminal tubes may be converted into small cysts which project from the fimbriated ends of the Fallopian tube, and are known as cysts of Kobelt's tubes. The main Wolffian duct generally atrophies, but occasionally runs down between the layers of the broad ligament close to the uterus, to open in the vagina near the urethral orifice, being then known as Gartner's duct. Cysts may occasionally arise in connection with this structure, projecting into the lateral fornix of the vagina.

4 The *processus vaginalis*, or funicular process, is the term applied to the protrusion of peritoneum which precedes the testis to form the tunica vaginalis, and which in the female accompanies the round ligament (*canal of Nuck*). Normally it becomes obliterated, but sometimes portions of it remain patent, and are distended with a

clear straw-coloured serous fluid, constituting in the male an *encysted hydrocele of the cord*, and in the female a *hydrocele of the round ligament*

## II Cysts due to the Distension of Pre-existing Spaces

(a) **Exudation Cysts** arise from the distension of cavities which are unprovided with excretory ducts, and are frequently of inflammatory origin. Such spaces may be lined with epithelium or endothelium. As illustrations of *epithelial* cysts may be mentioned those which arise in connection with the thyroid body, as also conditions due to the distension of the central canal of the nervous system (syringo-myelocoele), and those forms of ovarian cysts which arise from distension of Graafian follicles.

Exudation cysts lined by a serous or *endothelial* wall are much more numerous. Enlargements of bursæ, hydroceles of the tunica vaginalis, funicular process, or canal of Nuck, and some forms of ganglia, are of this nature. Diverticula or hernial protrusions of the synovial membrane of joints also occur, and are known as Baker's cysts.

A **Serous Cyst** is supposed to arise from the distension of lymph spaces, giving rise to uni- or multi-locular cavities, lined with endothelium, and containing a limpid straw-coloured fluid. They are seen most commonly in the neck, axilla, or breast, and in the latter structure may be surrounded by a dense, sclerosed, fibrous tissue. It is usually possible to dissect them out, but occasionally one has to rely on draining or packing them, so as to insure healing by granulation.

Adventitious bursæ are formed in a precisely similar manner.

(b) When a collection of blood forms in a pre-existing cavity, a so-called **Cyst of Extravasation** is produced. Such is met with in the pelvis or tunica vaginalis (hæmatocele), and also occasionally on the surface of the brain, constituting what is known as an arachnoid cyst.

(c) **Retention Cysts** always arise from obstruction to the escape of some natural secretion from a gland duct or tubule. The cavity thus formed is lined with epithelium, whilst, owing to the irritation produced by the tension, a fibro-cicatrical wall of variable thickness is developed outside. There is often a considerable formation of intracystic growths, especially in the breast, whilst the contents generally consist of the inspissated secretion, perhaps mixed with blood.

Retention cysts may develop in connection with any glandular tissue. The majority are described under the appropriate headings, viz, mammary cysts, renal cysts, pancreatic cyst, etc.

III **Cysts of New Formation** are such as occur apart from any embryonic condition or pre-existing cavity. The following varieties may be described



(a) An **Implantation Cyst** is one which arises from the accidental intrusion into the subcutaneous or submucous tissues of epithelial cells which retain their vitality, and are enabled to develop a cyst very similar in nature to a dermoid, in fact, it may be looked upon as an *Acquired or Traumatic Dermoid*. Such an occurrence is usually brought about as the result of an injury, especially from punctured wounds, thus, cysts of this nature have been met with in the fingers or palm of the hand as a consequence of the penetration of some sharp instrument, whilst they are also occasionally seen in the anterior chamber of the eye, following an iridectomy. They are, moreover, observed in the axillæ of cattle, as a result of goading them with a sharp implement. The clinical signs and treatment are similar to those of a dermoid cyst.

(b) **Cysts** may form around foreign bodies, which thus become encapsuled. They are lined with granulation tissue or endothelium, surrounded by a variable amount of fibro-cicatricial tissue.

(c) **Blood Cysts** are sometimes of doubtful origin. Some certainly arise from extravasation of blood, and are then filled with coagulated blood, or a thin serous fluid with a varying amount of laminated fibrin. In many cases a so called blood cyst is really a soft sarcoma, into which hæmorrhage has occurred, but a few instances are on record in which a thin-walled cavity existed, occupied by blood, and readily refilling after it had been tapped, and with no evidence of any growth. Such conditions have been most frequently observed in the neck (see Chapter XXXI).

(d) **Parasitic Cysts** are produced by the irritation caused by the growth within the tissues of certain living organisms. Thus, in the disease known as trichinosis, derived from eating unsound pork, the *Trichina spiralis*, a small round worm, develops in large numbers in the voluntary muscles, and becomes surrounded by a capsule which is subsequently calcified.

The most important of these parasitic cysts is that caused by the development within the body of the scolex stage of the *Tænia echinococcus*, giving rise to what are known as **Hydatid Cysts**. This disease is much more common in Australia than in this country. The *Tænia echinococcus* (Fig 60) is a

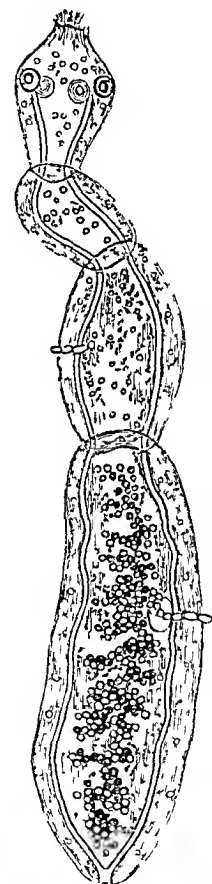


FIG 60—TÆNIA  
ECHINOCOCCUS  
X ABOUT 20

minute tapeworm, less than half an inch in length, which inhabits the intestinal canal of dogs, it consists of four segments, the posterior one being larger than the rest of the body, and containing the genital organs. When mature, this last segment becomes filled with ova, which are discharged, and these find their

way into the human stomach by the media of water or uncooked vegetables, such as watercress, which have been contaminated with the dog's excreta. The process of digestion sets the embryo free,



FIG 61 —HYDATID CYST (DIAGRAMMATIC), SHOWING DAUGHTER-CYSTS AND BROOD-CAPSULES GROWING FROM THE WALLS (AFTER BLAND SUTTON)



FIG 62 —DIAGRAMMATIC SECTION OF WALL OF CYST.

*a*, Fibro cellular capsule, here somewhat exaggerated *b*, lamellated chitinous layer, or ectocyst *c* brood capsules developing from the protoplasmic layer, or endocyst *d*, scolex, or separate head, enlarged

and by means of a crown of little hooks which it possesses, as well as four suckers, it is enabled to bore its way through the walls of the stomach, and thence travels by the bloodvessels to the liver or some

other part of the body. As a result of the irritation caused by its presence, a sac forms, which originally consists of three layers, externally, a fibro cicatricial layer, then an intermediate lamellated layer of chitinous material (true *ectocyst*), and finally the cyst is lined by a protoplasmic germinal layer (*endocyst*), from which may be developed solitary tænia heads or scolices, also provided with four suckers and a circlet of hooks, whilst sometimes groups of them, known as brood capsules, may arise in the same way (Fig 62). Daughter cysts are not unfrequently formed from the scolices, and they in their turn may pass through the same changes, although as a rule they are barren. Occasionally even the main cyst may be sterile (*acephalocyst*), and in such cases the walls become very definitely laminated. The fluid contained in the cyst varies much in amount, but is always of low specific gravity, not more than 1007, it is colourless, but slightly opalescent, limpid, and contains but a trace of albumen, although a considerable amount of chloride of sodium is present. On examining the fluid microscopically, the characteristic hooklets are observed. The organs usually affected by hydatid disease are the liver, kidneys, and brain, but any part of the body may be attacked. Occasionally in the liver, and usually in bone, multiple cysts develop quite distinct from each other, and with no general cyst-wall (*exogenous* multiplication). This can only occur when the ectocyst is thin, allowing the scolices, which always have a retractile neck, to push through and 'swarm off' into surrounding tissues.

Hydatid cysts give rise to no special symptoms, except those caused by their size and situation, and they are likely to go on growing until operative treatment becomes imperative on account of some complication, or from the size of the mass. At any time the cyst may *rupture*, either spontaneously or as the result of some injury, if into a serous cavity, such as the peritoneal or pleural, this becomes infected, and an abundant development of scolices and cysts ensues, giving rise to considerable localized inflammatory reaction, moreover, the escape of the cyst fluid may cause serious toxæmia, or, at any rate, urticaria, owing to the presence therein of some toxic substance.

Occasionally the organism *dies spontaneously*, and then the cyst shrivels up, and the laminated walls and daughter-cysts form a firm leathery mass, perhaps infiltrated with lime salts and of the consistency of wet mortar, a thick fibro-cicatricial capsule encloses the whole. At other times *suppuration* takes place within the cyst, and an abscess results. If acute, it bursts either externally, or may open into some serous cavity or hollow viscus, in the last case, the cyst may evacuate itself, and a spontaneous cure result. Sometimes the abscess becomes chronic and encapsuled, and may then remain quiescent for years.

For the diagnosis and treatment of hydatid cyst of the *liver*, see Chapter XXXIV. In other regions, if the tumour cannot be removed by dissection, reliance must be placed on drainage, where the situation of the growth renders this practicable, or aspiration, since it is

usually found that removal of the fluid contents causes death of the organism, probably by altering the intracystic tension

IV **Cysts of Degeneration** arise in connection with tumours, especially those where the blood supply is not very abundant. Thus, mucoid degeneration is not uncommon in fibromata, fibro-myomata, chondromata, and even in the harder forms of cancer. Occasionally cysts form in the sarcomata from this cause, but more frequently as a result of hæmorrhage

## CHAPTER IX

### WOUNDS

A WOUND has been defined as the forcible solution of continuity of any of the tissues of the body, but the term is more commonly limited to injuries of the soft parts, involving the skin or mucous membranes. Lesions in which the skin does not participate, and in which the deeper structures, such as bones, ligaments, etc., are not involved, are spoken of as contusions.

A Contusion is any subcutaneous wound or injury due to the agency of external violence, causing laceration of the cellular tissue, without necessarily involving such deeper structures as muscles, tendons, nerves, or bones. The signs are usually very obvious, viz., pain, bruising, or discoloration of the part, and swelling. These are readily explained by the injury inflicted on the subcutaneous tissues, which in the worst cases may be entirely disorganized and separated from the skin. The amount of bruising varies with the part injured and the severity of the lesion, thus, in the eyelids, scrotum, and vulva, where the tissues are lax, the ecchymosis will be very extensive and of a black colour, on the scalp there is, on the other hand, but little swelling, if the injury does not include bleeding beneath the aponeurosis of the occipito-frontalis. Again, the condition of the patient's general health influences the amount of blood effused, in a strong man in good training but little bruising is seen, whilst in those of a languid temperament and relaxed tissues a slight injury often produces a very conspicuous ecchymosis. Blebs and bullæ may form over the injured spot in bad cases. The changes that occur in a bruise are well known, the colour passing from a blackish-purple through various shades of brown and green to a yellow, which gradually fades and disappears, this is due to the disintegration of the red corpuscles, and staining of the tissues by the hæmoglobin thus set free, or by the products formed during its removal. When hæmorrhage has taken place into the deeper parts or under dense fasciæ, it is often some days before the bruise 'comes out,' and this may occur at some distant spot, *e.g.*, in the eyelids after a blow on the scalp, whilst after a fracture of the neck of the humerus the blood may travel along the muscular and fascial planes, and the bruise first appear about the elbow.

In a bruise or ecchymosis, the tissues are, as a rule, merely infiltrated with blood, but occasionally the extravasation is more localized, collecting in a cavity formed by the laceration of the tissues, and remaining as a fluid swelling, or Hæmatoma. It somewhat resembles an abscess to the touch, but differs from it in its history, having supervened immediately after an injury, and having appeared without any heat or other sign of inflammation, moreover, though at first fluid and soft, it soon becomes harder, whereas an abscess is preceded by a stage of brawny infiltration, and the softening occurs later. The subsequent history of a hæmatoma varies somewhat according to circumstances. (a) A deposit of fibrin may be formed peripherally, leaving for a time a fluid centre, which gradually disappears, and the whole is finally absorbed. This is well exemplified in a subpericranial cephal-hæmatoma, where the contrast between the fibrinous deposit without and the fluid centre is sometimes so accentuated as to give the impression of a depressed fracture. (b) The fluid portion of the blood may be absorbed almost entirely, and the solid fibrinous residuum may become organized into a firm fibroid tumour which persists indefinitely, the mass is more or less laminated, and not unfrequently pigmented. (c) The fibrin may be entirely absorbed, and a slightly pigmented fibrous capsule formed containing serous fluid, and constituting a definite cyst, such is best seen in connection with the cerebral tunics (*arachnoid cyst*). (d) Suppuration may ensue owing to infection from within the body, or from an invasion of organisms through abraded skin.

In forming an opinion as to the gravity of a subcutaneous injury, one must be guided by the part injured, the extent of tissue involved, the amount of blood extravasated, and the age and vitality of the individual. In the less severe cases, though there may be a good deal of bruising, recovery will ensue, but under less favourable conditions sloughing and death of the injured tissues may result.

The Treatment of a bruise usually consists in the application of cold or evaporating lotions and pressure in order to check the bleeding, but such must be used with care in old weakly individuals or where much laceration of the tissues has taken place, for fear of the injured parts dying. The skin should not be incised except under special circumstances, such as the rupture of a large artery, or when some definite advantage is to be gained by dealing at once with the injured structures, for though under careful antisepsis the dread of opening recent collections of blood no longer exists, yet it must not be lightly undertaken. At the same time, when a tense and painful hæmatoma exists, as under the fascia lata of the thigh, recovery can be hastened and pain relieved by an aseptic puncture, followed by careful compression. In general bruising of the body from a fall or extensive injury, pain can often be relieved by applying fomentations or by a hot bath. There is usually a certain amount of fever and constitutional disturbance for a few days, and these are dealt with by purgatives and a suitable limitation of diet.

## Open Wounds

An open wound may be defined as a solution of continuity of any superficial part of the body, including skin or mucous membrane. Various kinds of wounds are described, such as the incised, lacerated, contused, punctured, poisoned, and gunshot, but, of course, the most important distinction to draw is between the infected and the non-infected.

**I Incised Wounds**—An incised wound is one made by any sharp cutting instrument, but occasionally one not produced in this manner may be characterized by similar appearances, *e.g.*, the skin of the knee or elbow may be cleanly split open from falling on it with the limb flexed, and occasionally a policeman's truncheon will lay open the scalp almost as evenly as if a knife had been employed.

The special features of an incised wound are as follows:

1 **The hæmorrhage** is free, from the fact that the vessels are cleanly divided. The amount necessarily depends on the size of the vessels involved, and the vascularity of the part, its continuance upon the density of the structures allowing or not of contraction and retraction of the severed ends.

2 **Separation of the lips of the wound** also occurs, the amount depending upon the elasticity and character of the parts involved.

3 **Bruising of the margins of the incision** is absent, so that under ordinary circumstances rapid healing (by first intention) should obtain. The surfaces, to begin with, are lined by a microscopic layer of damaged tissue, some of which may be actually dead, but if suitable precautions are taken, this is absorbed, and in no way interferes with satisfactory union.

**Treatment of Incised Wounds**—Seven essentials must be attended to if healing by first intention is to be obtained, *viz.*

(1) **The Arrest of all Bleeding**—If there is general oozing, exposure to the air is often quite sufficient, or sometimes it may be supplemented by pressure for a few minutes with an aseptic sponge. Arteries and veins will need a ligature, but if situated close to the skin, they may sometimes be secured by passing under the bleeding spot the needle used for the suture. The importance of complete hæmostasis in limiting or hindering bacterial developments has been already alluded to (p. 4).

(2) **Sterilization of the Wound and its Surroundings**—This will be considered *in extenso* in Chapter X. In casualty work asepsis cannot be always assured, as the wound, though cleanly cut, is made through dirty skin, and portions of clothing, dirt, and splinters of wood or glass may be carried in. Under these circumstances the wound and its surroundings must be thoroughly purified, according to the rules given on p. 267, and a free use of 1 in 20 carbolic lotion, or even of Lister's 'strong mixture' (5 per cent. of carbolic acid with 0.2 per cent. of corrosive sublimate), is advisable, whilst foreign bodies are removed.

✓(iii) The coaptation of the opposed surfaces by means of sutures may now be undertaken. Many substances are employed for this purpose, but amongst the best are fine silver wire, silk, horsehair, silkworm gut and catgut. In casualty work, and for parts of the body where but little scar is subsequently desirable, as in the face, horsehair and silkworm gut, being non absorbent, are perhaps the best materials to employ, but in ordinary operative work, which will be more certainly aseptic, and where the after-treatment is more efficient, fine catgut or silk may be used. There are three chief varieties of sutures, viz, the buried, the deep, and the superficial.

*Buried sutures* are now largely employed, since a foreign body may be safely inserted into the tissues, if both it and the wound are aseptic. Some discrimination must be employed in the selection of the material chosen for a buried stitch, according to whether or not it is desirable that it should persist or be absorbed. If a part is not very strong and the cicatrix is exposed to a certain amount of tension, as in the abdominal wall after a laparotomy, non-absorbent material such as silk or silkworm-gut may be employed, and the incorporation of the suture in the cicatrix will prove a source of strength. At the same time it must be remembered that, if drawn too tight, the tissues within its grasp may be strangled, and suppuration at a later date determined even apart from external infection. In other cases all that is required of a buried stitch is to hold certain tissues in contact until a natural bond of union has developed, and then the sooner the stitch disappears the better—e.g., in building up the tissues of the neck after the removal of a goitre or in re-uniting a divided nerve, for such a purpose fine non-chromicized catgut answers admirably.

*Deep stitches*, or *sutures of relaxation*, are required in cases where there is difficulty in bringing the edges of the wound together, in order to transfer the tension from the healing margin to tissues further away, the edges being thereby relaxed. For this purpose thick silver wire may be employed, inserted 1 or 1½ inches from the margins, and tied directly, or lead buttons may be interposed next to the skin, and the ends of the wire fastened round the projecting edges, thus diffusing the pressure over a greater space. They are generally removed at the end of two or three days.

*Superficial stitches*, or *sutures of coaptation*, must be so inserted as to bring the edges of the wound into contact without undue pressure, and without any folding in of the skin. Various methods are employed, viz 1 The *interrupted suture* (Fig 63, A), in which each stitch is separately finished off, the knot lying well to one side of the incision. This is generally utilized for wounds which are of irregular shape or in which there is tension. 2 The *glover's stitch* (Fig 63, B) is a continuous one, in which the thread is carried on from point to point, and only fastened at the ends, it is not to be recommended. 3 The *blanket* or *buttonhole stitch* (Fig 63, C) is the form of continuous suture which should be employed for extensive wounds or incisions. In it the needle, after traversing the lips of



the wound, is carried under the slack of the thread, so that the loop of each stitch, as it is tightened, is maintained at right angles to the edge of the wound, whilst the intermediate portion lies parallel to it. To fasten it off, the needle is passed in the opposite direction through the edges of the incision, with the free end long enough to prevent it coming through, and so enable it to be tied to the double portion carried through by the needle. 4 Halsted's *intradermic* or *subcuticular* stitch (Fig 63, D) may be employed when very exact coaptation of the margins is desirable, and a minimum of visible scar required for cosmetic purposes, as in the face or neck. Fine silk-

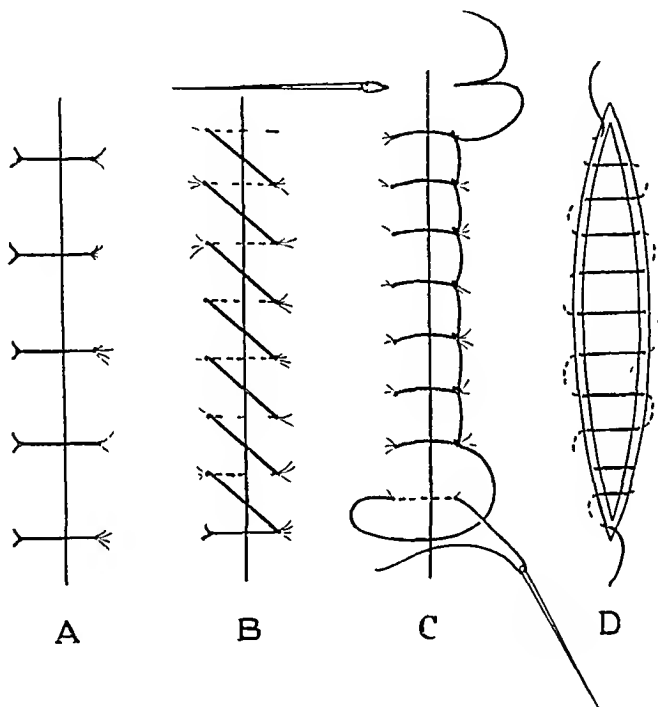


FIG 63 —VARIOUS FORMS OF SUTURE

A, interrupted suture B continuous suture C, blanket stitch At the lower end the needle has just been passed, and the way in which it catches up the loop is indicated. At the upper end the method of finishing off (originally suggested by the late Mr Maunsell) is shown viz the needle is passed in the opposite direction to all the other stitches the free end being left long so as to enable it to be tied into a knot with the double thread which the needle has carried through, D, Halsted's intradermic or subcuticular stitch

worm-gut or silver wire is employed, and a short straight needle. The needle is introduced in the substance of the skin beneath the cuticle and passed parallel with the surface, to emerge on the same level about a centimetre from the point of introduction, thereby taking up a semicircle of tissue, it is then introduced in a similar way on the opposite side of the incision, and the process is repeated from one end of the wound to the other. The suture is finally

pulled tight at each end, and left long. The process takes a little longer than the ordinary blanket stitch, but the cosmetic effect is much better. To remove it, one end is cut short, and then a sharp pull on the other end draws out the remainder quickly and without pain. 5 The *quilled suture* consists in tying the stitches round a quill or portion of catheter on either side of the wound, so that the deep surfaces may be maintained in apposition, whilst the superficial portions are left clear for additional sutures. The only conditions under which it is now used are in the operations for ruptured perineum, or for extensive perineal or urethral fistulæ. 6 The *twisted* or *figure-of-8 suture* consists in passing a pin or needle through the sides of the wound, which are brought into apposition by twisting silk around either end of the needle in a figure-of-8 fashion, nowadays it is but little used.

Plasters are sometimes employed instead of sutures, but the wounds must be very small and insignificant which only require such treatment. A fine aseptic suture is in most cases preferable.

(iv) **Drainage** must, if necessary, be provided, in order to guard against the irritation and tension caused by retained blood or exudations. In casualty wounds where there is doubt as to the completeness of the asepsis or hæmostasis, or where there has been much tearing or laceration of tissues, it is often wise to insert a tube for twenty-four or forty-eight hours.

When drainage is required, the indiarubber tube introduced by Chassaignac answers well, the end should be cut flush with the surface, and stitched to the edges of the wound so as to prevent it slipping in or out. For small wounds, a strand of horsehair or a strip of gauze or protective will usually suffice.

(v) **All fresh sources of irritation and infection** of the wound must be excluded by some form of antiseptic or aseptic dressing.

(vi) **Rest-to-the injured part** must be secured by such an arrangement of splints, slings, or bandages as may be necessary.

(vii) **The general health** of the patient is a most important item to attend to. In an operation case the bowels should, if possible, be previously opened, and the patient's diet carefully regulated, in casualty work a good purge should be administered as soon as convenient, and the food and drink limited.

Under ordinary circumstances an aseptic incised wound heals in about five-to-seven-days, but the actual time when it is safe to remove the stitches varies with the age and vigour of the individual, the part of the body, and the amount of tension required to draw the lips of the wound together. In ordinary aseptic operation wounds one usually removes the stitches on the eighth day, but in the face it is often possible and advisable to take them out earlier, partly because the healing process is quickly accomplished in such a vascular region, partly in order to minimize the amount of scarring.

Many conditions may arise to *prevent* the healing of an incised wound by first intention, and they may be epitomized as essentially the reverse of the seven conditions mentioned above—viz, (1) Non-

arrest of the bleeding, causing separation of the lips or deeper portions of the wound, (ii) the presence of impure foreign bodies or other septic material, (iii) the edges not being brought into contact, (iv) imperfect drainage, leading to tension on the stitches, (v) infection of the wound from various causes, (vi) lack of rest to the part, and (vii) constitutional conditions, such as deficient general vitality from disease or other causes

When blood collects in the deeper parts of the wound, the skin incision may heal satisfactorily, but there may be some local tenderness and a little swelling, and some slight fever, the temperature running up at night to about  $100^{\circ}$ . In such cases it usually suffices to open partially the incision, squeeze or press out the fluid, and insert a small tube or gauze drain. (For sepsis of wounds, see p 76)

II Lacerated or Contused Wounds—Such injuries are caused by blunt instruments, by machinery, missiles, the wheels of a vehicle, etc. They are characterized by the following signs

1 The Hæmorrhage is, as a rule but slight, since the vessels are torn across irregularly, and not cut cleanly, the middle and inner coats, which give way first, are curled up within the contorted outer coat, forming a barrier sufficient to prevent loss of blood. The vessels, being elastic, may be pulled out of their sheaths, and are sometimes seen pulsating upon the surface

2 The Lips gape less than in an incised wound, and are irregular, torn, and bruised. More or less extensive portions of dead tissue have to be disposed of before repair can take place, and hence this form of wound usually heals by granulation. When a limb is torn completely off, the tendons are often left long, and the muscular bellies project from their fascial sheaths as flabby congested masses, since the skin gives way at a higher point than the subjacent structures

The Progress of the case depends largely upon the question whether the wound is or is not aseptic

In an Aseptic lacerated wound it may be possible to bring the edges together by suture or otherwise, and, even though they are a little bruised, healing by a slightly delayed first intention is possible, if drainage is provided. If the wound remains open, the dead tissue is absorbed or separated, and an aseptic granulating surface results. There may be some simple traumatic fever for a day or two, but it is of little consequence

If the wound is Septic, however, inflammatory phenomena supervene, resulting finally in a granulating surface. Three stages may be described in the course of the case, viz

(a) The stage of injury, resulting in shock

(b) The stage of inflammation and sloughing, associated with septic traumatic fever

(c) The stage of repair by granulation, or prolonged suppuration, with exhaustion and hectic fever in the worst cases

The inflammatory period lasts a week, ten days, or more, according to circumstances, and during this period the patient is liable to

various forms of septic trouble, including secondary hæmorrhage, toxæmia, pyæmia, and traumatic gangrene

The Treatment of contused and lacerated wounds varies with their character, and no absolute rule of practice can be laid down to suit all cases. The following routine is that usually adopted

(a) **Immediate Treatment**—The great desideratum in all these cases is to render the wound aseptic. To accomplish this in severe injuries, it is wise to anaesthetize the patient, and then, after shaving the skin, if necessary, the wound and its surroundings are scrubbed with soap and carbolic lotion (1 in 20) by means of a sterilized nail-brush. Foreign bodies are removed, and dead or doubtful tissues cut away, if unimportant, whilst bleeding vessels are secured by ligature. Ample provision must be made for drainage, since the carbolic irrigation of itself causes much exudation, -occasionally it is desirable to make a counter-opening for this purpose. Ragged or torn fragments of skin are removed by knife or scissors, and then, if sufficient tissue remains, the wound may be loosely closed by a few interrupted sutures, and an antiseptic dressing of the usual type applied. If, however, the skin is scanty and asepsis not assured, it is better to leave the wound open, or, at any rate, only to partially close it, packing it carefully with gauze impregnated with iodoform.

(b) **Subsequent Treatment** depends on whether or not the measures adopted to obtain asepsis have been successful. If the wound remains free from infection, nothing special is called for beyond careful dressing. If it becomes septic, and the surface is covered with sloughs, these must be removed by natural or artificial means before healing can occur, the use of antiseptic poultices will considerably expedite matters, but it must be remembered that secondary hæmorrhage may occur when the dead tissues are finally detached. During this period inflammatory fever continues, and the patient's general health must be closely watched. When once a clean granulating surface is obtained, it is treated in the same way as any healing wound, skin-grafting possibly being needed in the more extensive cases.

The question of **Amputation** will sometimes be raised in dealing with the graver forms of lacerated wounds, although many limbs are now saved which would inevitably in former days have been sacrificed. Hard and fast rules cannot be laid down as to when to amputate and when not to do so, each case must be treated on its own merits. Apart from the local lesion, the following points must be carefully considered: (a) **The age and vitality of the patient**. An old person has less recuperative power than a young one, and hence a damaged limb may often be left in a youth which one would certainly remove in an elderly person. The vitality of the individual is perhaps even more important than the age, for some men at sixty are in a much more healthy and resistant state than others at forty. The habits, as to temperance, etc., must also be taken into consideration, and the existence of general diseases, such as diabetes or albuminuria, might induce one to resort to radical rather than con-

servative measures (b) The vitality of the extremity injured. A leg has to be sacrificed more frequently than an arm, since the vitality and reparative power of the latter are so much greater (c) The septicity or not of the wound is of the greatest significance, since, if infection can be prevented, the chances of preserving the limb are greatly improved, and one would then often delay operation, whereas sepsis would turn the scale in favour of radical interference

The local conditions which suggest or determine the performance of an amputation may be conveniently divided into two groups, viz, where amputation is essential, or where it is doubtful

A Amputation is certainly called for—

1 To trim up the stump of a limb torn off by machinery, or cut off by a railway train, or carried away by a cannon-ball

2 When the whole limb or one complete segment of it has been totally disorganized, or crushed to pulp, though still retaining its connection with the body

3 In cases where gangrene is imminent or has supervened, especially if it is of the spreading type

4 When severe septic symptoms develop in a case where an attempt is being made to save a limb, the retention of which was from the first doubtful, or when exhaustion supervenes from prolonged suppuration

5 In severe compound lacerations of the foot in old people, involving the bones and laying open the common synovial cavity. Septic arthritis and necrosis are then very apt to ensue, whilst the distance of the foot from the centre of the circulation increases the likelihood of gangrene

B Amputation is doubtful in the following conditions

1 Compound comminuted fractures in parts other than the foot do not *per se* require amputation, even if neighbouring joints are implicated. By careful attention to antiseptics, free drainage, and the removal of detached fragments of bone and foreign bodies, which should usually be accomplished under an anæsthetic, limbs formerly condemned to amputation can not only be preserved, but also restored to a considerable degree of functional usefulness. The final decision will mainly depend on the age, condition, and previous habits of the individual

2 When the soft parts have borne the brunt of the injury, and have been extensively stripped from the bones, amputation is by no means an essential, provided that they can be restored to their original position, that there is a reasonable probability of their vitality being maintained, and that the utility of the limb will not be hopelessly impaired, as a result of lesions to the nerves, after the wound has healed. The surgeon has here to balance carefully the risk run if an attempt is made to save the limb, and the value that the limb if saved will subsequently be to the patient. For instance, when the muscles of the forearm have been extensively torn up in a machine accident, it is a question whether it is worth while

exposing the patient to the risk of grave sepsis, when it is probable that under the best circumstances the limb will be of little practical use

3 Laceration of the main artery of a limb need not in itself determine amputation, but if in addition to this the bones, veins, or nerves are injured, and especially in the lower extremities of old people, amputation should be undertaken without delay

As to the Period when a limb should be removed after an accident, there is no doubt that, as a general rule, the sooner amputation is performed, the better, the longer it is delayed, the greater the risk of septic infection and absorption. On the other hand, the shock in some cases may be so profound that it is better policy to delay interference until reaction is established, this is especially the case in severe crushes close to the hip-joint, primary amputation in this locality being frequently fatal. At the same time, if shock is being perpetuated by the presence of a crushed limb, it should be immediately removed. When sepsis is present, and it seems desirable to remove the limb, there is no need to wait until defervescence has occurred, as used to be taught, as soon as the septic part is taken away, the fever and concurrent phenomena cease, provided that the amputation wound is maintained aseptic

**III Punctured Wounds and Stabs**—These may be brought about by any form of penetrating instrument, from a pin or needle to a sword or bayonet. The external opening may be in itself insignificant, the chief danger arising from the damage to deep structures—blood-vessels or nerves being divided, and serous cavities or viscera opened. The subsequent symptoms depend almost entirely upon the question of sepsis, there is always considerable difficulty in efficiently draining the depths of a long and narrow wound, and therefore collections of pus readily form and burrow in all directions

Wounds resulting from the modern sword-bayonet, though very serious from their size and depth, are not so difficult to heal as those inflicted by the old triangular blade. They should be thoroughly syringed out with warm carbolic lotion (1 in 20), well drained, and the skin opening not allowed to close until all discharge has ceased, if necessary, a counter-opening is made at a dependent spot. Serious hæmorrhage or paralysis, indicating that important vessels or nerves have been divided, calls for immediate opening up of the wound, so as to expose and deal with the injured structures

The commonest punctured wounds met with in civil practice are those produced by needles, which are frequently broken off short in the body, especially in the hands, feet, knees, or nates. If seen soon after the injury, it is advisable to undertake their immediate removal, a proceeding sometimes very simple, but occasionally necessitating a deep and difficult dissection. Should the needle not be removed, it may travel about the body along the muscular and fascial planes, and there is no knowing where it may lodge or come to the surface, or how long it may remain in the body. It occasionally finds its

way into the pelvis of the kidney, and constitutes the nucleus of a renal calculus

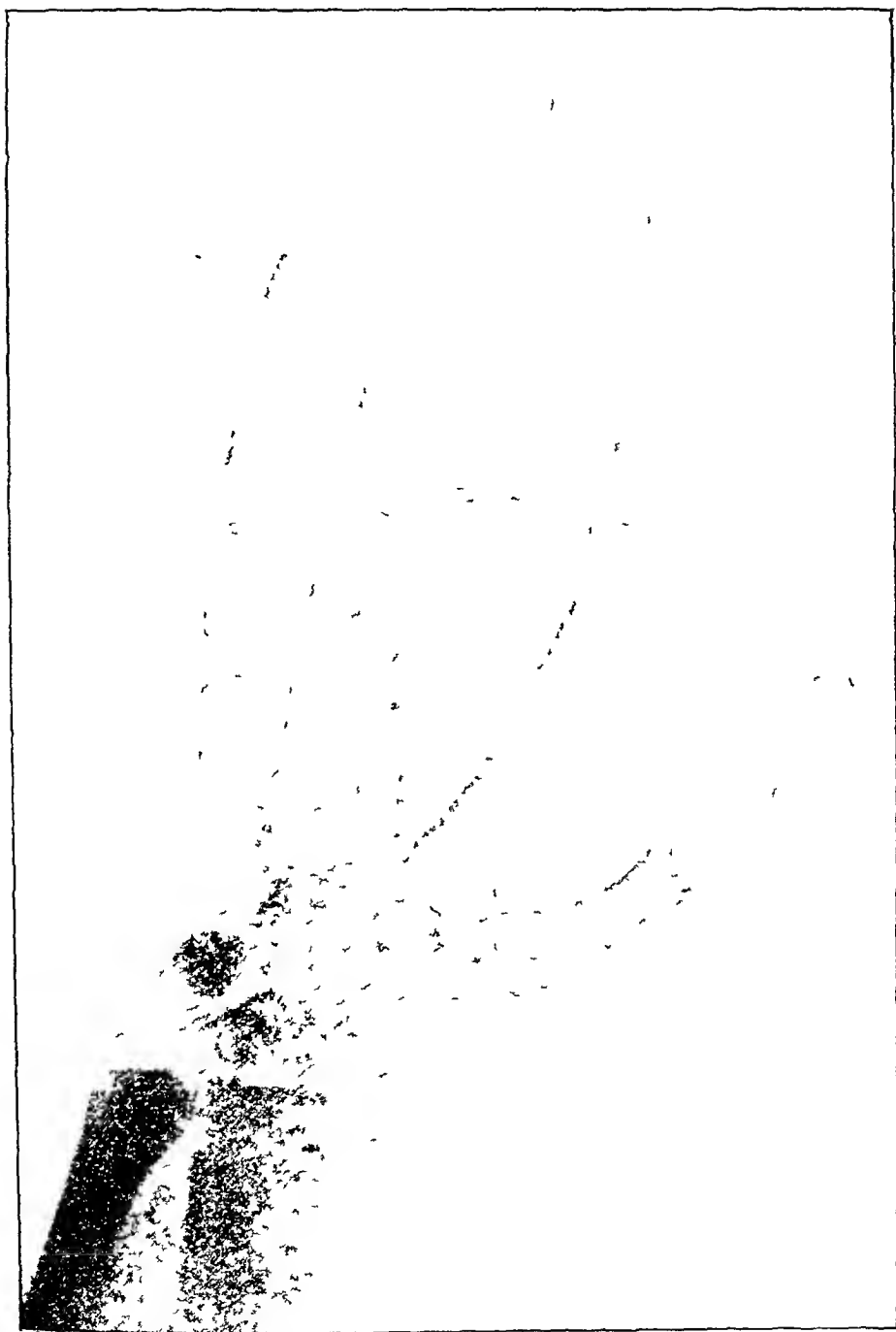
One of the most troublesome and painful forms of penetrating wound is that caused by a fish-hook, since the barbed end catches in the tissues, and it is impossible to withdraw it without increasing the size of the wound considerably. The simplest plan of treatment is to push on the hook and make it protrude through the skin elsewhere to such an extent as to enable the barb to be cut away, when the remainder of the hook will be set free.

For the detection of penetrating foreign bodies of a metallic nature, or of splinters of glass or stone, the so-called X rays of Röntgen are exceedingly valuable. They are produced by passing a powerful electric current through a modified Crookes tube, or, as it is now termed, a 'focus-tube'. This consists of a thin glass bulb, into which are fixed two terminals—one, the negative or cathode, concave, and the other, or positive pole, a platinum plate set at an angle, from which the rays are given off. A very high vacuum must be present in the tube. The rays thus generated, though invisible to the naked eye, have an actinic power, and are capable of affecting a photographic plate in the same way as ordinary sunlight. They are also able to penetrate many substances which are impermeable to ordinary light, although others resist their passage. Most of the soft tissues of the body are readily traversed, but bones and to a much less degree tendons are sufficiently resistant to cast a shadow on the plate, and it is the fixation of these shadows that constitutes the peculiarity of the so-called 'skiagram'. If a limb with a supposed foreign body within it is placed over a sensitive dry plate, held in a non-metallic dark slide or a black envelope, and the tube just above it, so that the convex portion on which the rays impinge is nearest the limb, a skiagram is produced which, on development, shows the osseous tissues, the outline of the limb, and the foreign body, if it exist (Plates III and IV).

A modification of this process has led to the production of the **Cryptoscope**. This consists of a cardboard screen coated with platino cyanide of barium, and if employed instead of a sensitive plate on the further side of the limb to the tube, the appearances produced can be seen by the naked eye. Since it is possible in this case to move the limb from side to side, or to rotate it, a better idea can be obtained of the position of the foreign body, by simple skiagraphy, it is often difficult to tell on which side of a bone the foreign substance lies. Still better results have been obtained by the application to this method of the principle of the stereoscope. Special methods of localizing foreign bodies have been introduced of late, but they are too complicated to be referred to here.

**IV Gunshot Wounds**—It is impossible in a work such as this to go minutely into the subject of gunshot wounds, but it is essential to indicate their most important features, and in what respect they differ from other forms of injury already described. The character

PLATE III

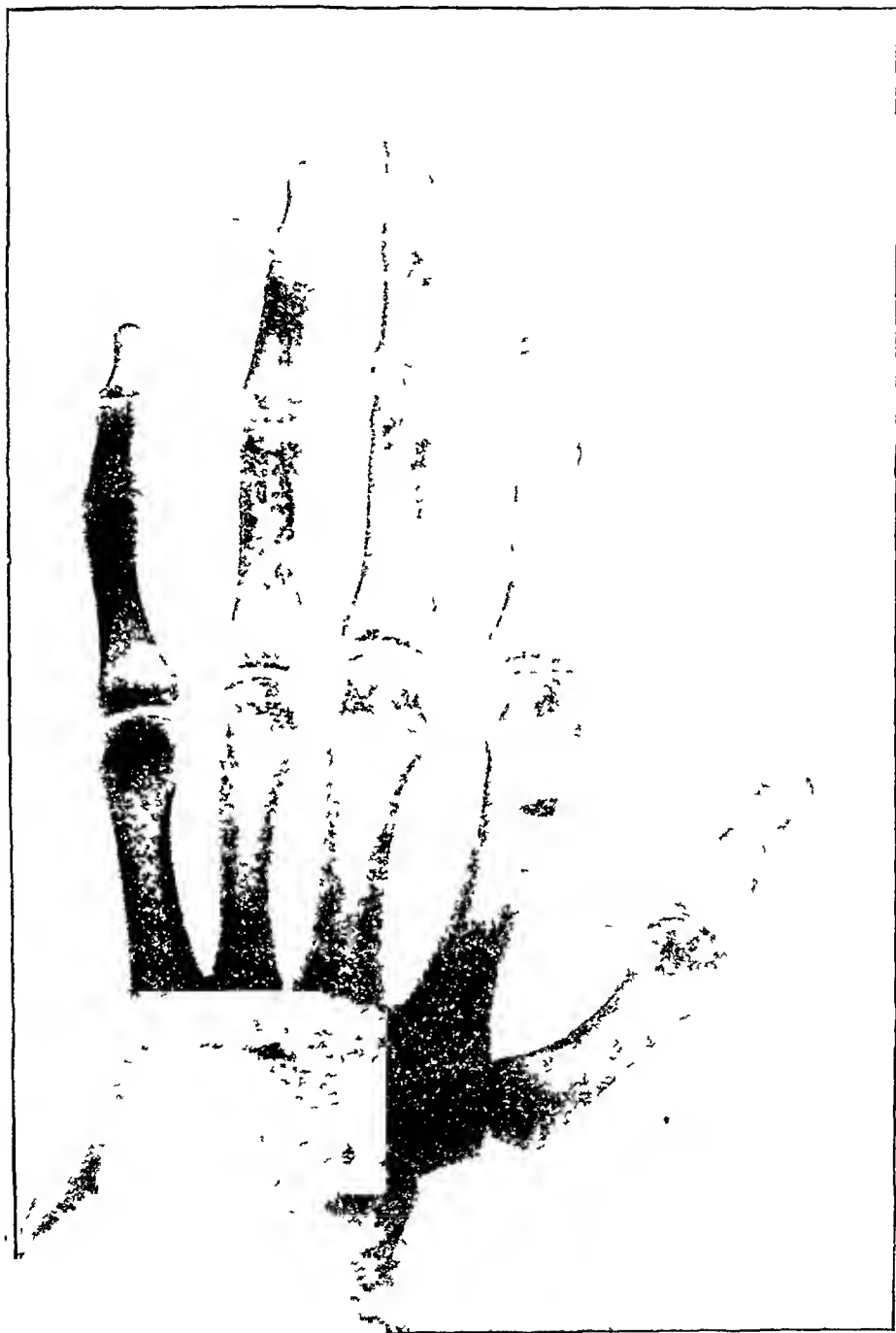


SKIAGRAM OF HAND, WITH NEEDLE EMBEDDED IN THE PALM, CLOSE TO THE  
CARPUS





PLATE IV



SPLINTER OF GLASS IN HAND, CLOSE TO METACARPAL BONE OF THE INDEX  
FINGER

It will be noted that the glass casts quite as dense a shadow as the needle in Plate III



of a gunshot wound varies according to the nature of the projectile, the arm employed, the velocity of the missile, the distance from the body at which the firearm was discharged, the part of the body struck, and the direction of the shot

The wounds inflicted by the modern small-bore rifle (*e.g.*, the Lee-Metford, Mauser, or Krag-Jorgenson) are very different to those produced in former days. The desiderata that have been considered in the evolution of the modern rifle have been to secure great muzzle velocity, a low trajectory, and clean and hard hitting. To this end the barrel has been rifled so as to cause the bullet to rotate on its own longitudinal axis (without such rifling the bullet would rotate on its short axis), and the bullet has been greatly modified, whilst the old form of gunpowder has given way to more highly explosive substances.

The modern bullet is a long, thin, conical body, consisting of a core of lead hardened by the addition of 2 per cent of antimony, enclosed in a cover, jacket or mantle of some smooth, hard metal, *e.g.*, 80 per cent of copper and 20 per cent of nickel (Lee-Metford and Mauser). The muzzle velocity is very high, amounting to 2,000 feet per second for a Lee-Metford rifle, and 2,300 feet per second for a Mauser. The trajectory is nearly flat, anything within 500 yards may be fired at point-blank, whilst in a range of 2,000 yards the bullet only rises 194 feet, as compared with 866 feet with the Snider bullet.

The effect of these arms varies to some extent with the range, but not nearly so much so as was formerly maintained, and although the worst wounds are usually produced at a short range, say 500 or 750 yards, yet quite simple wounds with no disruptive phenomena may also be caused at a similar distance. One of the best-marked features of these wounds is that the bullet travels straight and direct, without lateral deviation or deflection, as was so commonly the case in the old days. Simple flesh wounds are of no great importance *per se*, granted that important vessels and nerves are not injured. The aperture of entry is small, and looks somewhat 'like a bug-bite', the aperture of exit is slightly larger, and tends to be a little more slit-like. A certain amount of extravasation occurs into the tissues around the track, but the external bleeding is often slight. There is but little tendency to carry in portions of clothing or septic material, and the wound heals by first intention if reasonable precautions are taken. The external cicatrices finally look very similar to those produced by bad acne pustules. Vessels and nerves are not likely to be injured unless they are actually in the line of the bullet, the accurate limitation of the damage to this line is evident when one hears of a bullet passing between the abdominal aorta and the vena cava without either being injured. If a large artery is cleanly hit, the patient bleeds freely, and may die of hæmorrhage, unless it can be controlled by a tourniquet. If the artery is button-holed, a traumatic aneurism may result, whilst arterio-venous wounds were common in the South African campaign. There has been some

difference of opinion as to the character of the injuries to bones, that large masses of cancellous tissue (*e.g.*, the lower end of the femur) can be drilled cleanly without fracture is certain, but such wounds are sometimes associated with much splintering and involvement of neighbouring joints, possibly as a result of a short range, or of expansion of the bullet from the tearing down of the mantle. If a bullet hits cleanly the compact shaft of a long bone, it may smash the whole bone into small fragments, or the force may be more localized in its action, though always severe. Such comminuted wounds are very likely to become septic, if there is a long transport to the field hospital, and then fragments undergo necrosis and serious inflammatory phenomena follow.

Head wounds are much less fatal than might be imagined from the experimental work that has been undertaken. At close range frightful disruptive effects are produced, which are almost certain to be fatal (see Chapter XXV), at a longer range comparatively little mischief is done, except along the line of the missile. The inner table is always more splintered than the outer, and of course a certain amount of brain substance may escape. Abdominal wounds are also much less serious than formerly, a mortality of 90 per cent (American Civil War) being replaced by one of 40 per cent in the South African campaign, and that without operation (Treves). The mere penetration of one or more coils of intestine is not sufficient to cause general peritonitis, the wound is very small, and peristalsis seems to come to an end entirely as soon as the patient is struck, so that neighbouring coils of intestine or the omentum suffice to prevent faecal extravasation, indeed, many of the patients suffer but little constitutional or local disturbance. Of course, an empty intestinal canal is a favourable condition, and this is not unfrequently present on the field of battle. Bloodvessels may be wounded in the mesentery, and death result from hæmorrhage, solid viscera, such as the liver or spleen, are often damaged but little, granting a fairly long range. On the whole, the effect of these modern bullets is to disable without killing, unless a vital part is struck.

Soft-nosed Bullets (*e.g.*, the Dum-Dum) are characterized by the mantle being absent at the top, whilst the lead core is usually free from antimony. The result of this is that as soon as the bullet strikes, the lead core mushrooms out, and terrible mutilation or destruction of surrounding tissues ensues, whilst bones are comminuted and solid viscera pulped. A similar result follows from rubbing or cutting off the top of the Lee-Metford or Mauser bullet, or even from incising the cover in two or three places.

Martin-Henry and Snider Bullets produce wounds which are intermediate in their severity between the preceding two. The aperture of entry is usually small, that of exit large and with everted edges. Portions of clothing are frequently carried in by these missiles, and add to the risks of sepsis.

Shell Wounds have no special peculiarities beyond their severity and the ghastly nature of the injuries which may be inflicted by

them, depending on the irregular shape of the fragments into which the shell bursts

Dangerous wounds may be inflicted by small shot, as, for instance, when one of the pellets enters the eye, whilst the wads or other portions of the cartridge may also be carried into the body. A blank cartridge, if discharged at a short distance, may produce a severe wound, and under such circumstances the skin around is likely to be burned and blackened, leaving a permanent bluish-black tattooing of the tissues

The **Treatment** of gunshot wounds is conducted in accordance with general surgical principles, although it may have to be somewhat modified by the patient's environment and by the fact that after a battle the pressure of work may be such that all lengthy operative procedures have to be discarded. The first essential is to protect the wound from infection, and for this purpose the small packet of antiseptic-dressing carried by all our soldiers is admirable. Bleeding is, if possible, controlled by a tourniquet, and splints must be improvised for broken limbs, if practicable. As soon as the wounded man reaches the field hospital, the wound is more thoroughly explored and cleansed, foreign bodies are removed, bleeding-points secured, and if the bullet has not escaped and can be readily detected, it should be extracted. When lodged deeply, various appliances have been introduced to locate the exact position of a bullet, e.g., Nélaton's porcelain-ended probe or more complicated electrical contrivances, such as the telephone probe. Skiagraphy has also a large field of usefulness before it in this direction. Comminuted fractures are carefully investigated, detached fragments of bone are removed, and if an attempt is made to save the limb, splints, etc., are carefully applied. Primary amputations for bullet wounds are not very common at the present day, except when great comminution of bone or hopeless involvement of vessels and nerves has occurred. Wounds of the skull always demand the most careful attention, even when the bullet has penetrated cleanly and escaped, each opening must be trephined so as to allow of the removal of depressed splinters of the inner table. This rule holds good even when a bullet has merely ploughed a groove or track along the calvarium without penetration. The results of such treatment have been most admirable.

The treatment of abdominal wounds produced by small-bore rifle fire is generally one of expectancy. It has now been abundantly proved that patients can recover in the most astonishing fashion from bullet wounds which have traversed the abdomen from side to side or from front to back, and therefore unless there is some very clear indication, operation is better avoided. Moreover, the practical difficulties connected with abdominal sections, the frequent lack of sterilized water, of towels, and the dirty condition in which the patient is, owing to the exigencies of the campaign, together with the length of time that such an operation takes—all these constitute reasons for not interfering unnecessarily. Abdominal distension from hæmorrhage is one of the chief indications for

laparotomy In civil practice the ordinary rules of treatment are followed (Chapter XXXIV)

**V Poisoned Wounds**—The great majority of poisoned wounds are due to some definite micro-organism, and we have discussed their nature and characteristics elsewhere A few only remain to be dealt with here

**Stings of Insects**, such as bees and wasps, may be exceedingly irritating and painful, but are not dangerous, unless some local complication, such as erysipelas, supervenes, or the stings are very numerous, as when a swarm of angry bees settles on a person on the part involved is such as to lead to serious swelling, as in the pharynx or tongue, œdema of the glottis possibly arising under such circumstances All that is usually needed is the application of a weak alkaline lotion, whilst a common and efficient domestic remedy is a sliced fresh onion applied to the part Care must also be exercised to ascertain that the sting and poison sac are not left in the body

Some varieties of flies and spiders are also extremely virulent, and it is now certain that several forms of disease are conveyed by the former Thus, if a fly bites a person after feeding on putrid carrion, some form of septic inflammation may be originated, anthrax may also be spread in this way Mosquitoes, too, play an important rôle in the development of malaria and filariasis

**Snake-bites** require but little notice here, as they are exceedingly rare in this country, the common adder (*Coluber berus*) being the only venomous one likely to be met with, and even with this the poison is not sufficiently virulent to do much harm unless the individual attacked is a child or a person in a very bad state of health The poison is conveyed to the wound from the glands and poison sac situated on either side of the upper jaw through fine canals in the specialized teeth, which open at their apices, these teeth are so delicate in some snakes that it may be difficult to find the wounds produced by them The effects of an adder's bite are not, as a rule, noticed immediately, but come on in the course of an hour or so, extreme prostration supervenes, with a weak pulse, cold clammy perspiration, dilatation of the pupils, and perhaps delirium in bad cases, merging into coma

The **Treatment** consists in preventing the absorption of the virus by tying a ligature firmly above the wound, which should then be laid open so as to allow of free bleeding, and the surface excised or cauterized The collapse resulting from absorption of the poison is best remedied by the administration of stimulants or the hypodermic injection of strychnine

In India and other countries many varieties of poisonous snakes are met with, and wounds are frequently fatal, indeed, in India it is stated that 12,000 individuals are yearly destroyed in this way The symptoms come on rapidly, and are extremely severe, although they are modified according to the variety of snake The treatment

must necessarily be more energetic, probably the introduction of Fraser's antivenine will be the means of saving life

The **Anatomical Tubercle**, or **Butcher's Wart** (*Verruca necrogenica*), consists in a papillomatous development usually on the knuckles or wrists of those who are exposed to wounds either in the deadhouse or slaughter-house. It is in all probability a manifestation of tuberculous infection, and, indeed, resembles somewhat closely the appearance of lupus when it develops on the hands. Treatment consists in the application of a powerful caustic, whilst in bad cases it is necessary to scrape the surface before cauterizing.

**Dissection or Post-mortem Wounds** have obtained an unenviable notoriety in the production of serious inflammatory disturbance. It is well known that bodies are most virulent within a few hours of death, and hence the post-mortem room is more frequently responsible for these affections than the dissecting room, the care now exercised upon the preparation of subjects has greatly reduced the dangers due to the latter source. Inflammatory disturbances may arise from several distinct causes

- 1 The presence of strong antiseptics, such as arsenic, often irritates abrasions, and causes tenderness and congestion of the matrices of the nails

- 2 The organisms occurring in actual putrid material have no power of attacking living tissues, although some irritation may be caused by them if small sores or abrasions are present

- 3 Pathogenic organisms are frequently found in bodies soon after death, and are especially virulent when developing in the exudations from serous membranes, such as the peritoneum, hence both the surgeon who operates on the living subject, and the pathologist who examines the body after death, are alike exposed to serious risk either from an accidental puncture or from the infection of some abraded surface. It is even possible for infection to occur through the hair follicles of an unbroken skin.

The resultant lesions necessarily vary much in their nature. In the simpler cases all that ensues is a limited irritation of some abrasion or scratch, which rapidly disappears on the application of some sedative or antiseptic lotion. Suppurative folliculitis, or even boils, arise from infection of the hair follicles, and in worse cases the various forms of onychia, paronychia, or diffuse cellulitis, with or without suppuration in the nearest lymphatic glands. Severe toxæmic symptoms usually accompany the last-named conditions, and even acute septicæmia may develop.

The immediate treatment indicated for a dissection wound is to tie a ligature or handkerchief around the base of the wounded finger, so as to encourage bleeding and prevent the absorption of toxic materials, the part is then well washed under a tap of cold water, immersed in an antiseptic solution, and sucked for some minutes, an antiseptic dressing must then be applied. Any inflammation which arises subsequently must be treated according to the general rules of surgery.



A common result of poisoned wounds of the fingers, whatever their origin, is inflammation of the nail matrix (Chapter XVI), or of the tissues of the fingers, constituting a whitlow, and it will be convenient to describe the latter condition at this place

A **Whitlow** (*Paronychia* or *Panaritium*) occurs in four different forms, of which one is a true cellulitis, another a teno-synovitis, a third is a localized inflammation of the skin, and the fourth involves the terminal phalanx

(a) The **Subcuticular whitlow** consists merely in a development of pus beneath the cuticle which separates it from the cutis vera. It is very painful, but otherwise is of little importance. A boracic poultice preceded by the removal of the loose cuticle is all that is needed in its treatment

(b) The **Subcutaneous whitlow** is a true cellulitis commencing in the pulp of a finger, but often spreading upwards to involve the palm. The finger becomes swollen and painful, the pain being increased by pressure or by hanging down the arm. Gradually both these symptoms increase in amount the back of the finger becoming oedematous and the pulp more or less red. The swelling is at first hard and brawny, and even when pus is present it may be difficult to detect fluctuation unless the abscess is nearly pointing. Constitutional symptoms are not as a rule very severe, though the intensity of the pain may exhaust the patient. The hand should be elevated, and the finger poulticed. A free incision should be early adopted but, though free, must not extend too deeply or the tendon sheath may be opened and infected. Occasionally the pus forms at one or other side of the finger and the incisions must then be suitably modified. Antiseptic fomentations may be continued after such an incision, the constant moisture adding greatly to the patient's comfort

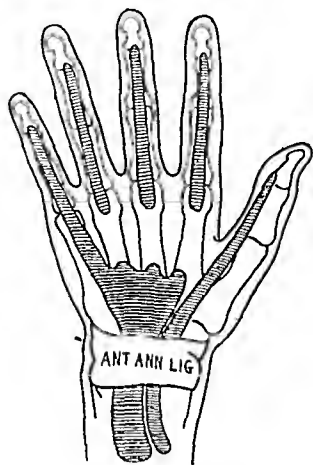


FIG. 64 — DIAGRAM OF SYNOVIAL SHEATHS OF FLEXOR TENDONS OF HAND

(c) The **Thecal form of whitlow** is really a suppurative teno-synovitis of the flexor sheaths. The signs are much the same as in the former variety, only more severe because the process is often more extensive. As special features may be mentioned the inability of the patient to bend the finger and the extreme pain caused on attempting to do so owing to the involvement of the tendon. The swelling also is more marked, and usually extends to the dorsum of the hand. The arrangement of the synovial sheaths in the fingers and palm is indicated in the accompanying diagram (Fig. 64), from which it is obvious that whitlows of the thumb and little finger are more dangerous than those of the intervening fingers. In the last case suppuration ceases at the level of the heads of the metacarpal bones but occasionally it oversteps this limit, and involves the palm in the same way as in the thumb and little finger. Free and early incision must be made to anticipate such extension and also to limit as far as possible the adhesions which the tendons are liable to contract or to prevent them from sloughing owing to the acuteness of the inflammation. In neglected cases the pus may burrow to the dorsum of the fingers, necessitating counter-openings or the periosteum may be affected, leading to disease or death of the phalanges the interphalangeal joints may also be disorganized. If the palm is involved, one usually endeavours to spare the superficial palmar arch and its branches, but in bad cases an incision is made down the centre of the palm irrespective of vessels, inasmuch as the superficial arch is easily picked up and tied. The incision should be made along the middle of the metacarpal bones involved, and not higher than the centre of the palm but an opening may also be necessary close to the

level of the wrist joint, and this can be made in the middle line without danger

(d) The Subperiosteal whitlow may be merely a complication of the thecal variety but it occasionally starts as an acute necrosis of the terminal phalanx arising either idiopathically or as a result of infection from the nail matrix. The inflammation may be limited to the end of the finger, or may spread to the palm. Free incisions, and the removal of the bone, if dead, constitute the treatment required

### Repair of Wounds

In former days five different methods of repair were described, but increased knowledge and further research warrant us in making the statement that there is but one method of repair, which, however, is modified according to the conditions of the wound, and that this process is essentially the same whatever tissue of the body is involved, be it bone, muscle, tendon, or subcutaneous connective tissue. It must be noted that repair is not synonymous with regeneration. It is very unusual for any tissue which has suffered from a serious lesion to be regenerated, fibro-cicatricial tissue, or some modification of it, forms the new bond of union between the damaged parts. In a few tissues, however, true regeneration has been noted—*e.g.*, in striped muscle, bone, tendon, nerves, and glandular structures, provided the injured parts have been brought into close apposition.

The general facts as to the process of repair may be stated as follows. The margins of the wound are always bounded by an area of tissue in a state of lowered vitality, even if no bruising or sloughing of the parts is present. The divided vessels are in a condition of thrombosis as far as the next patent branches, which in their turn are slightly dilated, partly as a result of this obstruction and partly from the reflex irritation of the injury. The surface of the wound is generally covered with a film of lymph or blood-clot, whilst any spaces left in the interstices of the tissues are similarly occupied.

(a) The first stage in the process consists in an abundant *exudation of small round cells*, presumably leucocytes, whose function is to remove all dead or damaged tissue, as well as to break up, disintegrate, and finally absorb, any blood-clot which is present. These cells are derived from the surrounding vessels, and are accompanied by a certain amount of serous oozing, so that we have here the early manifestations of a slight inflammatory reaction, which, if it does not extend beyond certain limits, is a beneficial proceeding. Should it, however, become excessive, as when bacterial invasion is present, injurious results may follow. Much discussion has arisen among pathologists as to whether or not this stage of repair is to be considered inflammatory in origin, the phenomena are, however, so exactly similar to those occurring in the earliest stages of inflammation that it is impossible to draw any line of distinction between them.

(b) The exudation of leucocytes is soon followed by the appearance of a number of large oval cells with abundant protoplasm and

large vesicular nuclei (Fig 65, D), these are termed *fibroblasts*, and are the cells which undergo organization to form fibrous tissue and bloodvessels. There is some difference of opinion with regard to the origin of these cells, the earliest idea was that they were migrated leucocytes, but this was abandoned in favour of the theory that they are derived from the cells composing the tissues of the part, being either connective-tissue corpuscles or endothelial cells

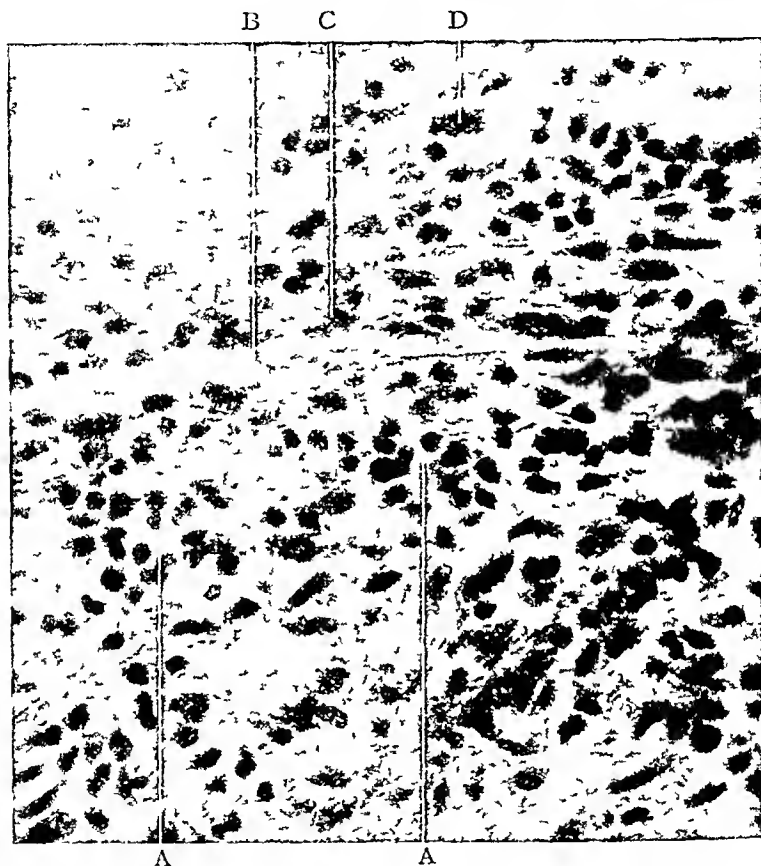


FIG 65 —GRANULATION TISSUE (EARLY STAGE)

A A are collections of small round cells' there are many others scattered through the section B is a newly-formed vessel, C its endothelial wall, D is a fibroblast

lining the capillaries, lymphatics, or lymph-spaces. But the ingenious researches of Ziegler and his school, who inserted into the peritoneal cavity glass chambers composed of two pieces of thin cover-glass, cemented a short distance apart, and watched the process of organization in this narrow space, have shown definitely that some at least of the fibroblasts are wandering cells derived from the blood. It is possible that these cells are in their turn derived from the endothelium, and that the endothelial cell is the fibroblastic

cell *par excellence* Whatever their origin, they soon form a layer of cellular tissue which lies upon or between the surfaces or lips of the wound, whilst the previously effused leucocytes disappear, some finding their way back into the circulation, and others serving as pabulum for the nutrition of the fibroblasts

(c) The *vascularization* of this cellular layer forms the next stage in the process This is brought about by the outgrowth from the walls of the nearest capillaries of solid rods of protoplasm (Fig 66, *a*), which appear first as minute buds, but rapidly increase in length, and may be single or double They soon bend over to unite with similar threads growing out from other capillaries, or with the wall of another vessel (Fig 66, *b*), or occasionally they unite with the vessel from which they started The connective-tissue cells may also become spindle-shaped, and send out branching processes to

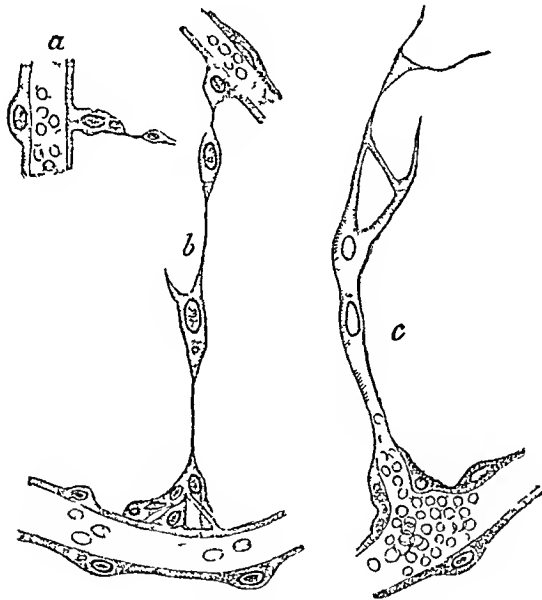


FIG 66 —NEW VESSEL FORMATION (AFTER TILLMANN'S)

- a* A small bud-like projection from the wall of a capillary *b* the union of such buds one with another, or with the branching processes of connective tissue cells, *c*, the canalization of these processes

unite with the offshoots from the vessel walls After a time these protoplasmic threads become canalized (Fig 66, *c*), and a communication is established between them and the mother vessel, so that blood passes into them The new capillary wall, at first homogeneous, soon becomes lined with definite endothelial cells, and strengthened by the connective tissue which forms around it By this means a soft vascular tissue is produced, known as *granulation tissue* (Fig 65), consisting of loops of capillaries supported by large nucleated cells with a varying amount of intercellular substance, which soon becomes fibrillated in texture

(d) The *transformation* of this granulation tissue into *fibro-cicatricial tissue* is next proceeded with. The fibroblasts become spindle-shaped, and finally long and narrow, with pointed extremities, which often branch (Fig 67), the nuclei also become long and narrow, and lose their vesicular appearance. The next stage of the process is open to doubt. The most probable view is that the periphery of the cell becomes converted into collagen, and is then split off from the



FIG 67—GRANULATION TISSUE IN A LATE STAGE OF ORGANIZATION FROM BELOW THE FLOOR OF A HEALING ULCER

A is a young vessel of new formation. B a vessel in a higher state of organization. The stroma between the vessels consists of loose fibrous tissue in which numerous fibroblasts are embedded. There is a strong resemblance between these and the endothelium lining the vessels.

mother cell to form a fibril of connective tissue, this process is repeated until almost the whole of the protoplasm is used up, the nucleus and a small area of protoplasm remaining as a connective-tissue cell, or as an endothelial cell lining a lymph cleft. An alternative theory is that these fibrillæ are formed as an inter-cellular exudation. By the contraction of these fibres the cells

become flattened out and compressed, and the newly-formed vessels constricted, so that as time passes the scar tissue becomes less and less vascular, and consequently firmer and denser, as well as smaller.

(c) Whilst this last stage is in progress, the surface of the wound is covered over with cuticle, which spreads inwards from healthy epithelium in the neighbourhood of the wound, and especially from the deeper layers of the rete Malpighii.

As already stated, the general process of repair sketched above is modified according to the character and condition of the wound. Four chief modifications are met with in surgery.

1 **Healing by First Intention or Primary Union** occurs in cleanly cut aseptic wounds where the lips are unbruised and brought

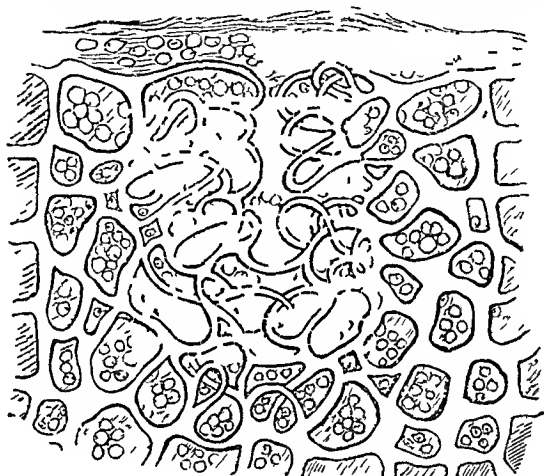


FIG 68 —DIAGRAM OF HEALING BY FIRST INTENTION (AFTER BILLROTH)

The wound is occupied by a fibro cellular growth, into which loops of capillaries extend constituting granulation tissue, whilst the epithelium has united across the surface

together, so that no extensive collection of blood or discharge between them is possible. A thin layer of blood-clot lies between the surfaces of the wound and penetrates into its meshes, and the contraction of this clot is at first the chief means of keeping the deeper parts in apposition. There is but a microscopic line of damaged tissue, which, together with the blood-clot, is easily absorbed, and the process runs a typical course, as sketched out above, union being effected in five to seven days (See Figs 68 and 69).

2 **Healing by Granulation**, or second intention, as it used to be termed, is met with (a) in cases where there has been definite loss of substance, so that the lips of the wound are not, or cannot be, approximated, as also (b) when the surface of the wound is bruised or damaged so that portions of tissue have to separate by sloughing, or (c) when the advent of sepsis has prevented the occurrence of primary union.

When a small amount of aseptic dead tissue is present, it is removed, as previously described (p 96), by an invasion of leucocytes from the surrounding vessels, which disintegrate and gradually absorb it. These are followed by the fibroblasts, which form a layer of granulation tissue on the surface of the wound (Fig 70). If there is much slough to be dealt with, the vitality of the granulation tissue cannot be maintained beyond a certain distance from its source of nutrition, and so by a process of simple anæmic ulceration the unabsorbed dead portion is cast off and a granulating surface

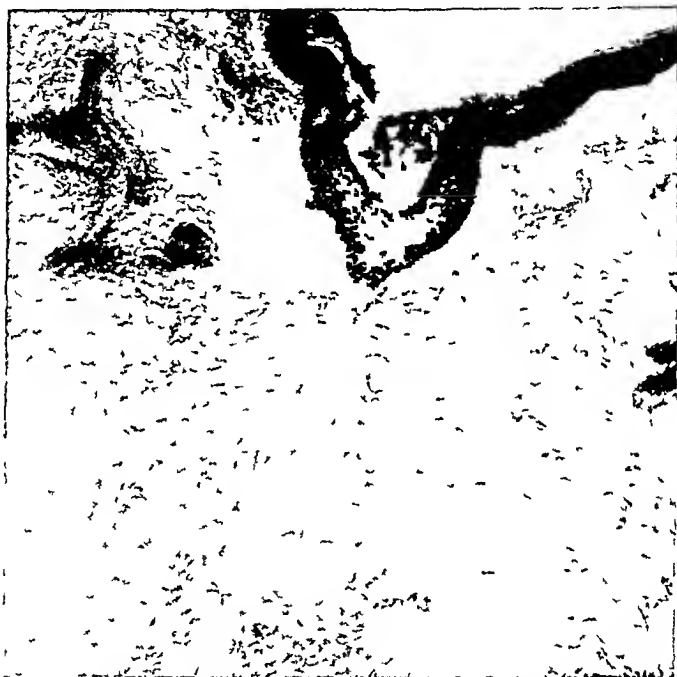


FIG 69 —SECTION OF A WOUND HEALED BY FIRST INTENTION TEN DAYS AFTER ITS INFLICTION

The epithelium is drawn in to form a V-shaped notch and beneath is a mass of fibro cicatricial tissue with comparatively few cells or vessels evident

remains. If the slough is septic, ulcerative inflammation occurs in the adjacent living tissue, which brings about a similar result, though accompanied by suppuration and septic fever. When, however, there is a simple loss of substance, with no bruising or damage to the tissues, the course of events is as follows. The blood-stream in the superficial capillaries having been arrested, adjacent vessels become dilated, and from these an exudation of plasma and leucocytes results. The plasma coagulates on the surface and forms a layer of fibrin, entangled in the meshes of which are a number of white corpuscles, so that the wound becomes covered with a film of whitish-yellow material known as lymph. This gradually increases

in amount and thickness, and is vascularized from below into granulation tissue, this process occupying from four to seven days

The healing of a granulating wound is brought about by the conversion of the granulations into fibro-cicatricial tissue, and by the surface becoming covered with cuticle. The contractile tendency inherent in all cicatricial tissue produces two results from its presence in the base of the wound beneath the superficial layer of granulations (1) The surface area of the wound is diminished in all directions, a most important element in the healing process, since if the base is adherent to some dense resisting structure repair is slow and difficult, and the wound may remain open as a so called chronic ulcer. When the granulating surface is very extensive, contraction may proceed to such a degree as to obliterate many of the vascular channels, and by thus depriving the superficial tissues of their



FIG 70 - DIAGRAMMATIC REPRESENTATION OF THE LATER STAGES OF HEALING BY GRANULATION (AFTER BILLROTH)

adequate nutrition, the healing process may be indefinitely prolonged (11) The depth of the wound is diminished, partly by the continuous growth of granulation tissue from below upwards, but also by the contractile base lifting the deeper structures to the surface. If the base of the wound cannot be raised, the cicatrix is usually depressed and adherent to the underlying parts.

During the process of repair the wound takes on the appearances already described as characteristic of a healing ulcer (p 90)

3 **Healing under a Scab** is a proceeding that can only take place in very small wounds, such as superficial grazes and abrasions, and is practically identical with the granulating process, except that, instead of an artificial dressing applied by the surgeon, the lesion is covered by a scab which consists of clotted blood or dried exudation. Should sepsis be present, pus is likely to accumulate beneath the scab and give trouble.

4 **Healing by Organization of Blood-clot** is only observed in strictly aseptic wounds where there is definite loss of substance, as in the



deep channels made in the treatment of bones thickened by chronic osteitis. Blood is allowed to collect and coagulate so as to fill the cavity, and the surface is covered with protective to prevent irritation from the dressings. The dark coagulum shows no trace of change for some days, but gradually the peripheral portions become granular and yellowish-white in colour, these are gradually vascularized and transformed into granulation tissue, which in time spreads over the whole surface from periphery to centre, and then healing occurs as described above. The clot is absolutely passive in this process, being infiltrated by leucocytes and removed by degrees, and thus



FIG 71 —SCAR FROM A RECENTLY HEALED SUPERFICIAL WOUND (LOW POWER)

The epithelial surface is regular and devoid of papillæ, the scar tissue has an abundance of cells scattered through it, as well as some very obvious vessels, which would almost entirely disappear at a later date

merely serves as a basis of support or scaffolding for the building up of the granulation tissue which replaces it

A Scar is a mass of fibroid tissue covered by epithelium, which has been formed in the repair of a wound (Figs 69 and 71). It is at first vascular, and contains cells of the connective-tissue type, but after a time, as contraction continues, the cell elements become flattened out, fewer in number and less obvious, the intercellular fibrous tissue more abundant, and the vessels constricted, so that finally a scar becomes well-nigh bloodless. Where superficial, its colour changes from red to white, and if of small size it may almost

disappear, but never absolutely, unless the subcutaneous tissue has not been involved. When the parts around become injected by any cause, such as sharp friction, the anæmic scar tissue again becomes evident by contrast. Lymphatics, nerves, hairs, and cutaneous glands are all absent, except perhaps at the periphery, and the epithelial covering itself is merely a uniform layer without papillæ.

The Pathological Phenomena connected with scars are as follows

1 **Excessive Contraction**, which may lead to great deformity, especially when the wound has occurred in the flexure of any of the joints. A web-like mass of fibroid tissue then forms, limiting movement, and requiring operative interference. A seriously burned hand may by cicatricial contraction be fused into an unsightly mass, rendering the fingers of little use, similarly, the chin may be drawn down and practically fixed to the sternum, and the lower lip everted, as the result of a burn on the front of the neck. The *Treatment* of such conditions consists in dividing the cicatrix, and thus freeing the parts, during which process it must be remembered that deeper structures of importance, such as the main vessels and nerves, may be adherent to the under surface, and thus be endangered. When once the scar has been divided, there is often no difficulty in restoring the parts to their normal positions, although when the contraction has existed for any length of time it may be advisable to do this slowly, even by gradual extension with a weight and pulley, so as to avoid any risk of lacerating the deeper parts, which are usually contracted secondarily. The raw surface formed by the opening out of the contraction has now to be covered with epithelium by some form of skin grafting or by a plastic operation, most of the cases can be dealt with by Thiersch's method (p 91), but the results, though promising for a time, are often ultimately disappointing.

2 **Overgrowth of the scar tissue** is sometimes met with, constituting what is known as the false or **Alibert's Keloid**. This most frequently occurs in the scars of burns or of wounds in tuberculous patients, but may arise from any cicatrix, presenting itself as a fibroid indurated mass of a dusky red colour, with perhaps a number of dilated vessels coursing over it, which occupies the region of the old scar, and may possibly send claw-like processes into neighbouring healthy structures. It consists merely of a hyperplasia of the scar tissue, but as to its ætiology nothing is known. With the exception of somewhat severe pruritus or itching, its presence entails no inconvenience, although if it occurs on exposed parts it may be very disfiguring. Removal is useless, since the keloid almost always recurs in the new cicatrix and in the stitch holes. After a longer or shorter interval it often disappears spontaneously.

3 **Ulceration of Scars**, the result of defective nutrition, is a troublesome condition to deal with, as repair is usually slow.

4 **Painful Scars** arise from either the implication of a nerve terminal in the cicatrix, or the pressure of a contracting scar upon the bulbous end of a divided nerve, as in amputation stumps. In each case further operation is necessary, in the former the cicatrix or at any

rate the painful portion of it, is excised, whilst in the latter the stump must be opened up, and the enlarged end of the affected nerve removed

5 **Malignant Disease of Scars**, or of old chronic sores but partially healed, is of an epitheliomatous-type, and appears as a hard ulcerated tumour with everted edges, a thickened base, and usually a good deal of foetid discharge (*Marjolin's ulcer*). The progress is very slow, since the vascularity of the tissue is slight. It is painless, from the absence of nerves, and as long as the disease is limited to the scar, no lymphatic implication will be noted. As soon, however, as the malignant growth invades healthy tissues, the usual phenomena show themselves. The diseased tissues may be freely dissected out, having regard to subjacent structures, and the wound closed by some plastic method.

### General Conditions connected with Wounds

I **Shock**—By the term 'shock' is meant a general depressed condition of the nervous system, resulting from some energetic stimulus, which is either transmitted to the vital centres in the medulla from the peripheral sensory or sympathetic nerves of an injured part, or may descend to them from a disturbance of the emotional centres through the nerves of special sense. **Local Shock** is a curious condition of insensibility to pain on handling, which is sometimes present after severe injuries, and is especially seen in gunshot wounds. Possibly it is due to some temporary paralysis of the sensory nerves.

The term **collapse** is applied to a condition very similar in nature to shock but differing from it mainly in its onset, which is gradual, and often preceded by some exhausting disease, and by the fact that muscular relaxation is more complete. The collapse of cholera is one of the most typical manifestations, but any condition associated with loss or derivation of fluids from the vessels may give rise to it—e.g. prolonged vomiting or serious hæmorrhage. If at the same time septic absorption is taking place, the symptoms are still more marked. Thus in acute peritonitis the two factors, removal of fluid from the circulation and toxæmia, are proceeding concurrently. Shock usually tends to recovery, unless the lesion is of a serious nature, and then collapse may supervene and prove fatal. Thus, after rupture of the intestine the immediate symptoms are the result of shock but they are quickly followed by the collapse due to acute peritonitis.

The degree of shock experienced in any particular case is mainly influenced by the following factors

(a) The severity and extent of the injury Speaking generally, the amount of shock varies directly with the depth of the wound, since the deeper the wound, the greater the violence which has produced it, but in some cases extensive superficial wounds produce a more severe effect than limited deep ones, owing to the larger number of nerves involved, along which stimuli can be carried to the centres, thus, an extensive superficial burn is more likely to produce fatal shock than the complete incineration of an extremity.

(b) The site of the injury The more essential and sensitive the

organ injured, and the more closely it is connected with the chief sympathetic or cerebral centres, the greater will be the shock, thus, a small wound of the intestine, stomach, or any of the viscera, is much more serious than an extensive accident to one of the limbs

(c) The nervous susceptibility of the patient is a most important element, for the more highly organized the nervous system, the greater is the amount of shock experienced, and *vice versa*, although long-continued suffering may render an individual less susceptible than usual, especially if sedative drugs have been employed. Prison surgeons find that amongst the coarser and baser types of criminals operations may be performed without an anæsthetic in a surprising manner

(d) The expectation, or not, of the injury When the whole nervous system is maintained in a state of tension, anxiously expecting the receipt of some painful impression, the effect produced will naturally be increased, whilst if the attention is diverted, and interest actively aroused in other things, the shock at the time is much diminished, though its effects may be subsequently greater. Thus, in the keen excitement and nervous tension of a battle, soldiers have often been wounded severely, and yet not known it at the time, whilst the pain of the most trifling cut may produce deep shock when the patient is in a state of dread and anticipation

The **Symptoms** vary with the injury inflicted, from a slight momentary giddiness and faintness (known ordinarily as an attack of syncope or a fainting fit) to immediate and complete prostration, insensibility, and even death. The pulse is at first small, slow, and weak, but soon becomes irregular, extremely rapid, and often imperceptible, the countenance is pallid and shrunk, and the brow covered with cold sweat, the respirations are slow and shallow, whilst the temperature is usually subnormal

After an interval, the length of which depends on the severity of the lesion and the treatment adopted, *reaction* occurs, being introduced by increased depth and frequency of the respirations, the pulse becomes slower and fuller, the surface warmer, whilst consciousness and muscular power are gradually restored. During this period it is not unusual for an attack of vomiting to supervene, probably due to hyperæmia of the brain following the anæmia which has been responsible for most of the preceding symptoms

When serious loss of blood has also occurred, the phenomena of hæmorrhage are associated with those of shock, the pulse is sometimes of the hæmorrhagic type (p 272), the blood is altered in its characters, and great restlessness may be present

Sometimes reaction is accompanied by irritability, either of the mental or muscular systems, in the one case leading to traumatic delirium, which is always of grave import, and in the other to intense restlessness, as in the shock which follows extensive burns. It is possible that in both these conditions a toxic element has been introduced. The term *cerebric* shock is sometimes applied to these manifestations

Occasionally the evidences of shock are delayed in their appearance for some time after the injury, and come on gradually. Especially is this the case after railway accidents when no great injury has been experienced, for a time the anxiety and excitement are such that no depression is noticed, but as the mental perturbation passes off, the individual experiences symptoms very similar to the above, but probably rather of the nature of neurasthenia than of real shock (see Chapter XXIII). When an accident occurs to a person in a state of intoxication, it is not unusual for the phenomena of shock to be delayed for some time, only showing themselves when the effect of the alcohol has passed away.

**Pathology**—The *post-mortem* evidences are not very characteristic, but they all point to a loss of control of the nervous system over the vascular, resulting in anæmia of the brain and superficial parts of the body, and enormous engorgement of the abdominal viscera, lungs, and great venous trunks, the heart contains practically no blood, although it is probable that the right side is much distended at the time of death, especially when due to sudden injury, and subsequently empties itself by post-mortem contraction. The *explanation* of the phenomena of shock is by no means simple, and several factors are probably needed to produce the complex result. 1 Reflex inhibition of the heart's action through the cardio-inhibitory centre in the medulla explains the early syncope with slow pulse. It is well known that if a frog's abdomen is opened and the exposed intestine sharply struck, the heart stops in a condition of diastole, whilst if the vagi are previously divided, no effect is produced. Any severe peripheral injury may lead to such a result, especially those directed to the great sympathetic centres in the abdomen which are closely connected with the vital centres in the medulla. In this way sudden death may be produced by a severe blow in the epigastrium, or by drinking a glass of very cold water, when hot. This inhibition of the heart's action is never prolonged in mammals. 2 Exhaustion of the vasomotor centre in the medulla is probably the chief cause of shock, by leading to a marked fall of blood-pressure. Crile,\* who has most carefully studied this subject, shows that stimulation of the central end of a divided nerve causes a rise of blood-pressure at first, but if the stimulation be repeated often, this rise gradually diminishes, disappears, and in time is represented by a fall. This depression is provided for by a nervous mechanism, which opens up the splanchnic area and allows the blood to collect in the larger veins of this region. The supply of blood to the brain and surface is therefore diminished, the portal system being over-full. It is also obvious that any considerable hæmorrhage will aggravate the vascular trouble.

**Diagnosis**—1 From the general results of *hæmorrhage*. Restlessness and thirst are then prominent signs, together with a sense of dyspnoea, causing rapid respiratory efforts, the mental condition, moreover, is less affected, and the patient is generally sensible, the

\* 'An Experimental Research into Surgical Shock' by G. W. Crile. J. B. Lippincott Co. 1899.

surface is excessively blanched, and the pulse may have a marked hæmorrhagic wave 2 In *concussion of the brain* there are superadded to the symptoms of shock those more particularly connected with the region affected, *i.e.*, the intellectual centres, so that unconsciousness is the predominant feature, whilst loss of memory of the accident and of the events which followed is often noticed 3 When *vomiting* is approaching *under* the influence of an *anæsthetic*, the patient's pulse usually becomes weak and rapid, and the countenance pale This condition closely simulates shock, and is often distinguished from it only by the progress of the case Under such circumstances, if vomiting is plainly imminent, it is sometimes wise to increase the amount of anæsthetic, as the patient is usually not fully under its influence

**Treatment**—In slight cases very little is needed beyond resting quietly for a few minutes, or the exhibition of some aromatic stimulant to the nostrils, such as ammonia or smelling-salts In the more severe cases the patient is laid recumbent, with the head low, hot bottles, well protected, and blankets are applied to the trunk and extremities to maintain and increase the bodily temperature If able to swallow, a little warm tea or stimulant may be administered, but if unconscious, a hot coffee or brandy enema, small in bulk, or a hypodermic injection of ether or strychnine ( $\frac{1}{10}$  v. of the B P injection); is necessary It must be borne in mind that the patient has, in most cases, only to be tided over a certain period of depression before reaction naturally follows, so that it is important to economize vital power, and not to waste it by over-stimulation

The injection of hot saline fluid (1 drachm of chloride of sodium to 1 pint of water) into a superficial vein, the rectum, or the subcutaneous tissues (submammary or gluteal for choice), has been employed with considerable success of recent years The *modus operandi* of intravenous infusion is described at p 273, the fluid should be introduced at a temperature between 105° and 110° F Several pints may be injected to begin with, the exact amount being governed by the reaction of the patient If after a few hours symptoms of depression again supervene, the injection should be repeated

According to Crile, the most valuable remedy for shock is an intravenous injection of a solution of adrenalin (1 in 50,000 or 100,000 parts of normal saline solution), a few cubic centimetres being allowed to enter the circulation each minute The clinical value of this proposal has not yet been ascertained He also suggests\* that when shock is anticipated, it is well to clothe the patient in a special close-fitting pneumatic suit, which can be inflated when necessary by a bicycle pump The effect of this is to produce an artificial peripheral resistance, which will assist in emptying the subcutaneous veins and determine a flow of blood to the heart The pneumatic suit has been used in many clinical cases, and the reports are encouraging

An important question is often raised as to the advisability of performing an operation during shock As a general rule, it may

\* Crile, 'Blood pressure in Surgery' p 288 J B Lippincott Co, 1903

be stated that operation should be deferred until reaction has come on, unless the presence of the injured organ, such as a badly crushed limb, is evidently prolonging the condition. Under these circumstances a hypodermic injection of morphia may improve the condition by relieving pain; otherwise the condition should be at once dealt with, and it will be often found that, as the patient passes under the influence of the anæsthetic, the pulse improves, and the state of shock disappears, the anæsthetic shielding the medullary centres from the painful afferent stimuli. In urgent cases, especially when due to an intraperitoneal lesion, where operation must be undertaken without delay, the use of a saline injection into the venous system prior to operation is often most advantageous.

Shock may to a large extent be *prevented* during operation by a careful attention to such details as keeping the patient well covered up and as warm as possible, by perhaps operating on a hot-water table, by minimizing hæmorrhage, and by rapidity and cleanness of execution. A hypodermic injection of strychnine, or a brandy and beef-tea enema, given just before the operation, is also useful, and it must be remembered that incomplete anæsthesia tends to increase the shock rather than to prevent its occurrence.

**II Traumatic Fever**—Traumatic fever is that which follows the receipt of an injury, whether simple or compound, or after an operation. Two main varieties are described.

(a) **Simple Traumatic Fever** occurs after subcutaneous injuries, such as sprains, contusions, fractures, etc., and after aseptic operation wounds or compound injuries. It is thus found in conditions where micro-organisms are absent, or, if present, are in such a state as to be practically impotent. The generally acknowledged cause is the absorption from the blood-clot or inflammatory exudation of some chemical substance (possibly the fibrin ferment), which has a pyrogenic effect upon the medullary centres. Probably the fever following aseptic operations is largely determined by the use of irritating antiseptics, which increase the exudation and may damage the tissues considerably, if mild antiseptics or sterilized salt solution are alone used to irrigate open aseptic wounds, this so-called 'reactionary fever' will be absent, unless other elements, such as retained serous discharge or accumulation of blood, are present. Occasionally fever is observed in cases where we have no grounds for supposing that absorption of fibrin ferment is taking place, it may then be due to some peripheral irritation, e.g., a badly-fitting splint, and disappears immediately on the removal of the cause.

The symptoms are those of slight pyrexia, reaching  $100^{\circ}$  or  $101^{\circ}$  F within twenty-four or forty-eight hours of the injury, with coated tongue, loss of appetite, etc., gradually passing off in three or four days. If thus limited, it is of no prognostic importance.

(b) **Symptomatic Traumatic Fever** is that caused either by the absorption of the products of putrefaction, resulting from the vital activity of organisms in discharges, blood-clot, or dead tissue, or from the

absorption of the toxins connected with a development of parasitic organisms in the wound or its surroundings, or from the supervention of some general infective disorder. All these different conditions have been dealt with elsewhere, and require no further notice.

**III Traumatic Delirium.**—Although delirium is merely a symptom which is superadded to others in certain cases, it is occasionally of so pronounced a character as to demand special attention. Three forms are met with.

(a) The **Active Delirium** which accompanies severe injuries, particularly in plethoric, and often in previously healthy individuals, whose environment has been suddenly changed from that of everyday life to a sick bed in a hospital ward. Septic contamination of the wound is usually present, and the delirious state is associated and runs a parallel course with the traumatic fever. It is not usually of a violent type, although the patient may be irrational and restless, he moves the injured part without any evident appreciation of the pain which, if conscious, he must suffer, but he is easily restrained by the exhibition of firmness and tact on the part of the attendant. The symptoms are most marked at night, and commence at the end of forty-eight hours, lasting, as a rule, for two or three days. There is a distaste for food, which, however, can be overcome by gentle persuasion.

**Treatment**—Patients in this condition must never be left, the diet should be light, but nourishing, the bowels are thoroughly opened, and an icebag to the head may be useful. The wound should be freed from any septic accumulation.

(b) **Delirium of a Low Muttering Type** is met with in individuals of low vitality, exhausted by dissipation, drink, disease, or faulty hygienic surroundings. It is commonly associated with fever of an asthenic type, such as is seen towards the end of septic or infective diseases. The patient usually lies on his back, staring vacantly upwards, is incoherent, takes no notice of surrounding objects, and is observed to pick at the bedclothes and mutter to himself unintelligibly. There is often, in addition, an involuntary escape of urine or fæces. The mouth is generally open, the tongue dry, brown and cracked, and viscid mucus collects about the teeth (*sordes*).

The **Treatment** should be directed to careful nursing and feeding, as by that means alone can the patient be saved.

(c) **Nervous Traumatic Delirium** is observed in individuals who, previously of intemperate habits, have suffered some serious injury, such as a compound fracture. The violent symptoms do not set in till about the third day, but are usually preceded by some amount of sleeplessness and wandering at night, or the patient may have short snatches of sleep, from which he awakes semi delirious. This gradually increases, and is followed by violent delirium of the worst type (*delirium-tremens*), in which the patient is haunted by terrifying visions of reptiles, horrible insects, and the like, from which he tries in vain to escape. During this stage of excitement he is with



difficulty restrained from jumping out of bed, in many instances these patients are remarkably cunning, and, managing to elude the vigilance of their attendants, will succeed in escaping from the room by the door or window, and may inflict serious, and even fatal, injuries upon themselves or others. There is always a tremulous condition of the extremities and of the tongue, which is white and coated, whilst the bowels are obstinately confined. The pulse and temperature vary considerably, and the skin is often moist and clammy. The violent stage is always followed by profound exhaustion, in which the patient may gradually sink into a state of coma and die. In the case of a fractured leg, the struggles of the patient will cause considerable displacement of the limb, and necessitate constant attention to prevent further mischief. The limb should never be fixed to the bed, but slung in a Salter's swing or immobilized in plaster of Paris.

**Treatment** — In cases where an attack of delirium tremens is considered imminent, either from the previous history of the patient, the tremulous state of his hands and tongue, or his sleeplessness, the best treatment to adopt is to support the strength by suitable food and a medium dose of stimulant, combined with free purging and, if need be, soporifics (chloral, bromide, paraldehyde, or morphia), under such a regimen the symptoms usually soon disappear. In the acute maniacal attacks the patient must be fully controlled and guarded, but with as little manifestation of restraint as possible. Nourishing food (possibly of a fluid type), with a certain amount of stimulant, should be administered during the quiet intervals, and sleep obtained by drugs, especially morphia hypodermically, a quarter of a grain should be given at first, and more if necessary. Free purging is of course essential.

## CHAPTER X

### THE GENERAL TECHNIQUE OF MODERN SURGERY

No one who has been brought up in the modern school of antiseptic or aseptic surgery can have any idea of the horrors that were perpetrated under the name of surgery by our ancestors. Anæsthesia was unknown, and perhaps this was an advantage rather than otherwise, as it limited the number and the scope of operations. Patients had to be forcibly restrained during the procedure, hæmostatic forceps were not in existence, and the operating theatre was not the quietly decorous spot that it now is, but rather resembled the shambles. The wards were a hotbed of surgical fever, and erysipelas, pyæmia, and other manifestations of pyogenic infection led to an appalling post-operative death-rate. Hospital gangrene, wound phagedæna, and other affections now happily extinct, were common enough, and not unfrequently wards had to be entirely closed in order to limit the ravages of such diseases. The almost synchronous discovery of anæsthesia and antiseptics has transformed surgery, and from being an art dangerous, barbarous, and almost repulsive, it has been changed into a scientific procedure, beautiful in its details and beneficent in its results. In this connection the names of Simpson, who fought the battle of anæsthesia, of Spencer Wells, who popularized the use of hæmostatic forceps, and of Lister, who first applied to surgery the principles that were being taught by Pasteur as to the microbic origin of disease, will ever stand out as three of the greatest benefactors of the human race.

The Antiseptic plan of treating wounds, as originally introduced by Lord Lister, is an outcome of the germ theory of putrefaction. It has for its object the prevention of bacterial development in wounds by the use of *chemical agents*, some of which are true germicides, capable of destroying the bacteria, whilst others merely prevent or inhibit their growth. Innumerable methods of applying this treatment have been adopted, and the plans originally suggested have been much modified in the direction of simplicity. Amongst the multifarious antiseptic agents which have been used, the most prominent are carbolic acid, corrosive sublimate, biniodide of mercury, iodine, iodoform, formalin, boric acid, salicylic acid, etc.

**Carbolic Acid**, the first antiseptic introduced by Lister, has a direct germicidal action in strong solutions, and an inhibitory effect in weaker ones. The crystals,

when heated with 10 per cent of water, constitute an oily fluid known as pure or liquefied carbolic acid, which is a powerful though superficial caustic, and may be applied without much fear to infected living tissues—*e g*, to tuberculous sinuses or wounds—after scraping them, in order to destroy any portions of tuberculous material which may have escaped the spoon. Excess of the acid may be washed away with absolute alcohol, which quickly dissolves it. The liquid carbolic dissolves in water on the application of warmth, and the 1 in 20 and 1 in 40 solutions are those mainly employed, the former is an efficient and potent antiseptic, but must be used carefully on delicate skins. It is most important to insure the complete solution of the acid, as otherwise globules of it may be deposited on the hands or in the wound, and may do much harm. Carbolic acid is frequently somewhat crude and impure, and many of the irritative and toxic phenomena are due to cresylic acid and other substances which should not be present. General absorption of this reagent leads to darkening of the urine, which may become olive-green or even black in colour, and this carboloria is often associated with a rise in temperature and some intestinal irritation, whilst diseased kidneys may be seriously affected. Weaker solutions are more readily absorbed than the liquefied or pure acid.

**Corrosive Sublimate** is a valuable though very poisonous remedy which is usually employed in solutions of 1 in 2,000, 1 in 1,000 or 1 in 500. Occasionally the last of these three solutions has 5 per cent of carbolic acid added to it, constituting what is known as Lister's *strong mixture*. Sublimate solutions are inhibitory in action rather than germicidal, but are potent and reliable. They have less power of penetration than carbolic acid, and have less hardening or roughening influence on the skin. If, however, a dressing soaked in a sublimate solution (1 in 2,000) is kept for long in contact with the skin, it acts as a direct irritant, and may lead to an abundant formation of pustules, owing to the activity of the germs in the deeper parts of the cutis which have not been destroyed by the antiseptic. Instruments should not be placed in sublimate solutions, as even if plated, they soon lose their bright appearance. It must be remembered that individuals very sensitive to the action of mercury may be salivated by this agent.

**Bimiodide of Mercury** is a potent antiseptic, which has been chiefly employed in the form of a 1 in 500 solution in 70 per cent methylated spirit for the purification of the hands or of the skin of the patient. It is, of course, extremely toxic. A 1 in 2,000 aqueous solution is also employed for the hands, and is less harmful to instruments than the perchloride.

**Boric or Boracic Acid** is a mild and weak antiseptic, which may be utilized when stronger remedies might prove harmful—*e g*, in plastic operations and for infants. It is also useful when antiseptic fomentations are required in treating inflammatory phenomena.

**Iodoform** is a yellow powder of characteristic and unpleasant odour which probably acts by being decomposed in the tissues and slowly giving off iodine. Commercial iodoform is usually contaminated with a variety of germs, as may be shown by dusting it over a film of nutrient gelatine and allowing them to develop. It is therefore wise to wash the iodoform before use in 1 in 20 carbolic lotion or some such antiseptic. Its chief value is in septic or tuberculous wounds, and, indeed, it seems to have a specific inhibitory action upon the development of the *B. tuberculosis*. It may be suspended in glycerine (10 per cent), and after sterilization by heat this can be injected into tuberculous tissues, joints, or abscesses, or if open wounds exist gauze soaked in this emulsion, as it is incorrectly termed, may be packed into them with advantage. Toxic effects of very variable type may follow from undue absorption of the drug. Gastro-intestinal disturbances, vomiting, diarrhoea, colic etc., may be the chief symptoms, but delirium and collapse often supervene. There is always an abundance of iodine in the urine. Various substitutes have been proposed in order to avoid the unpleasant smell—*e g*, aristol, orthoform etc.—but they are of doubtful value. Perhaps the best means of obviating the odour is to mix with it  $\frac{1}{10}$  part of Coumarin, the active principle of the Tonquin bean, which has a powerful aroma.

Chinosol is a yellow substance, harmless and free from toxic qualities it is freely soluble in water, and possesses powerful antiseptic properties.

Lysol is another useful antiseptic derivative of coal tar. It is freely soluble in water and as a 2 per cent solution may be used in syringing out cavities such as the vagina, external ear etc. One of its great advantages is that the solution is somewhat sticky, and tends to cling to the tissues and prolong its action.

Potassium Permanganate, Sanitas, and Peroxide of Hydrogen all act in the same way as oxidizing agents: they are necessarily unstable and cannot be utilized for dressings and are therefore chiefly employed in the disinfection of cavities or wounds already contaminated. The most potent of these is peroxide of hydrogen, which is sold as a fluid capable of setting free 10 to 20 times its volume of nascent oxygen. It is quite unirritating and may be poured directly into a septic wound, or even into the peritoneal cavity: forthwith it commences to effervesce, liberating its oxygen and forming a frothy foam which is likely to bring to the surface any loose foreign bodies. Its use is particularly indicated in the treatment of septic ulcers, carbuncles, sloughy abscess cavities and the like. Sanitas and potassium permanganate of potash are used in solutions of varying strength, and act more slowly: the latter has the disadvantage of staining the tissues with which it is brought in contact.

Formalin is a powerful antiseptic, and consists of a 40 per cent aqueous solution of formic aldehyde. It is decidedly toxic even in a 1 per cent solution. It blackens steel instruments and hardens the skin to an unpleasant degree.

The Aseptic Method of treating wounds consists in the elimination of chemical antiseptics as far as possible, and the substitution of heat, dry or moist, as a sterilizing agent. Every efficient antiseptic is more or less toxic and irritating, and there can be no question that, from an ideal standpoint, the less they are introduced into wounds, the better. No more satisfactory germicide can be imagined than heat, in the shape either of boiling water or of steam under pressure, and it is claimed that if everything brought in contact with the wound is aseptic, then no antiseptics need be employed. Of course, there are two elements in an operation which can never be sterilized apart from chemical antiseptics—viz, the skin of the patient and the surgeon's and assistants' hands—and thus the most complete aseptic precautions can never entirely eliminate chemical agents. Moreover, it must not be forgotten that the air itself holds numberless germs which cannot be excluded from the wound, and that such germs are more numerous in crowded cities and in places where sick people are likely to congregate. To obviate this, most elaborate precautions have been taken in the shape of filtering the air admitted to the operating theatre, and also as to the cleanliness and dress of the surgeon and his assistants. For these it is strictly logical that the whole head should be enswathed in a sterile cloth with the exception of the eyes, since the scurf of the hair is septic, and the saliva is similarly contaminated, and it is impossible to move the head without detaching fragments of the former, or to speak without ejecting minute drops of the latter. Unsterilized persons, and therefore students, should be banished from the operating theatre, or placed behind a glass screen, as every additional onlooker must increase the risk in purely aseptic conditions. Then, too, the surgeon must be able to rely on assistants and nurses who are not changing

every six or twelve months. Hence, in a large teaching hospital, devoted to the training of students and nurses (and such, we believe, can only be effectively carried out by their active participation in the work), it is almost impossible to maintain a purely aseptic clinique. Whilst we have adopted many of the methods suggested by those who are able to insure complete aseptic precautions, we still cling to not a few of the measures originally introduced by Lord Lister, and which we have found, both in his hands and in our own work, give such excellent results.

The *actual details of operative technique* vary somewhat with different surgeons, but the main principles which govern modern operative surgery are much the same in all, and the following sketch of the preparations required and of the routine usually practised in undertaking an operation may be considered more or less typical of modern methods.

**I The Operating Theatre or Room** — The arrangement of this necessarily depends upon considerations of space and finance, and the ideals of the modern aseptic surgeon are seldom attainable. Thus, strictly speaking, no septic case should ever be dealt with in an aseptic theatre, no one should enter it without first bathing and donning an aseptic garb, the air should be thoroughly filtered before its admission, and all unnecessary sightseers kept away.

For practical purposes, however, much less rigid precautions have to suffice. The operating theatre should not be unnecessarily large, and the old-fashioned room with tiers of seats overlooking the central area is not desirable. Onlookers should have a low gallery provided for them, but little raised above the floor space and shut off from it not merely by a rail, but by an effective closed barrier breast high. It may with advantage be placed between the operating area and the source of light, but clear of the window, and should be entered by a separate passage and not through the theatre. A north light is desirable, and it should come, not from the top, but from the side, in the form of what is known as a 'studio light'. The walls should be lined with white tiles, glazed bricks, marble or alabaster, or at least painted with white enamel, which can be washed down with a hose. The floor must be impermeable, and slope towards a circular aperture or drain, discharging over an open head through the outside wall, so as to allow of suitable flushing with a hose. All shelves must be made of glass, but the fewer fixtures in the actual theatre the better. Attached to the theatre should be a suitable series of smaller rooms for the anæsthetist, for sterilizing purposes, etc.

In a private house the room should, if possible, be carefully prepared beforehand. The carpet should be taken up and curtains removed. The walls should be wiped over with an antiseptic solution, and the floor thoroughly scrubbed, all unnecessary furniture is removed. Should the operation be an emergency one, without time for such complete preparation, it is often wiser to leave things alone, and not stir up dust and dirt by a hurried attempt to make things look a little better than they really are. A suitable supply of hot

and cold boiled water must be secured beforehand, and basins and dishes, etc., should, if possible, be previously boiled

2 The Surgeon and his Assistants must remember the extremely grave responsibility that rests upon them in undertaking many of the modern operations, and must be willing and ready to submit themselves to the strictest régime. The coat must be removed, and the sleeves of the shirt and vest turned well up above the elbows, and retained there, if need be, by safety-pins or suitable clutches. A mackintosh apron may then be donned, and over it a sterilized cloth apron, wet or dry. We do not consider that it is necessary to wear a head cover, although ideally this should be the case, especially when the individual is hairy, if, however, he is suffering from a nasal catarrh, the mouth and nose should certainly be covered with a damp cloth. Unnecessary talking during the operation is forbidden, and, whenever possible, directions should be given by signs. If it is necessary to cough or sneeze, the head must be turned aside completely. The antiseptic habit must be so ingrained as to become automatic, and it should be impossible for a surgeon to take a handkerchief from his pocket and blow his nose or wipe perspiration from his brow, and then resume the operation, without effective re-sterilization of the hands. Those who have the misfortune to perspire easily must be most careful not to allow drops of sweat to fall into or near the wound.

The same rules hold good in regard to the *nurses*, who should also turn up their sleeves above the elbows. The hair should be arranged quietly under a cap, and a fringe avoided. Long tails to caps are out of place in the operating room.

Much of the success of an operative clinique depends upon the methodical and effective organization of the same. It is desirable that all unnecessary hands should be eliminated, and therefore everything likely to be needed should be laid out within reach of the surgeon and his assistant on a suitable side-table, so that they may be able to take up instruments, ligatures, sutures, etc., without being touched by others.

3 The **hands** are scrubbed thoroughly with soft or ether soap and hot water (preferably sterilized), the nails are cut, if need be, and cleansed, special attention being directed to the semilunar folds of skin at the base, where septic material is so apt to collect. For this purpose a purified nail-brush is employed with advantage. The hands are then immersed in an efficient antiseptic lotion—*e.g.*, a 1 in 500 solution of biniodide of mercury in 70 per cent methylated spirit for one minute, and then in 1 in 40 carbolic or 1 in 2,000 sublimate solution. The hands, once purified, should not be dried except on a sterilized towel, indeed, it is better to keep them moist and redip them from time to time during the operation either in the 1 in 40 carbolic or 1 in 2,000 biniodide of mercury or sublimate solution, and in intraperitoneal work in sterilized salt solution (31 to 1 pint). Another plan consists in immersing the hands and forearms in a saturated solution of permanganate of potash, after thorough washing

with soft soap and water, until they become a deep mahogany-red colour. They are then placed in a warm saturated solution of oxalic acid until completely decolourized, and are finally washed over with sublimate solution. This method is apt to cause a certain amount of irritation of the skin of the forearms. It is possible that in many instances complete sterilization of the hands is not effected, but the surgeon must always keep complete asepsis of his hands before him as an ideal to be attained. On several occasions when our hands and those of our assistants were tested bacteriologically after the use of the biniodide of mercury and sublimate solutions, they were found to be sterile, even scrapings from beneath the nails giving no reaction. Some authorities have been so concerned at the imperfection of their results that they are in the habit of operating in sterilized cotton gloves, frequently changed during a lengthy operation, or in thin rubber gloves, which can be sterilized by boiling. We are extremely doubtful as to the value of this plan, and feel that a certain degree of delicacy of touch must be sacrificed thereby. Careful attention to the skin after operations—*e g*, the application of glycerine at night, so as to prevent it becoming rough and harsh—is a most important element in success.

4 **Instruments** are sterilized by boiling them in a weak solution of bicarbonate of soda (1 per cent) for five or ten minutes. To prevent them from rusting, they should be carefully plated, and the water ought to boil for some minutes before they are immersed, in order that the suspended air may be driven off. After boiling they may be laid out on a sterilized dry towel and covered over with a similar towel till they are required, or kept in a weak antiseptic solution (*e g*, carbolic lotion, 1 in 60). Mercurial solutions should be avoided, as they spoil the instruments. If during an operation an instrument which has not been previously sterilized is required, it may be quickly purified by immersing it for half a minute in liquefied carbolic acid, the excess of which is removed by washing thoroughly in alcohol or hot sterilized water. The same process or re-boiling must be adopted for any instrument which falls on the floor or becomes otherwise soiled. Special care must be directed towards the forceps to see that the serrations are freed from dried blood clot and other dirt. Hæmostatic forceps must be opened before boiling.

5 **Sponges**, unless very carefully treated, are a fertile source of mischief, but their power of absorbing blood and other fluids is so much superior to that of any other agents that many surgeons still retain their use. They should be thoroughly purified in 1 in 20 carbolic lotion before use, and wrung out of a 1 in 40 solution of carbolic or a 1 in 2,000 sublimate or biniodide of mercury solution during the operation. Only a limited number of sponges—say, two or three—is used, and the assistant cleanses them in a bowl of lotion placed in a suitable position. Sponges should never be used for tuberculous disease or rectal operations, or for any conditions where pus is present, or if so used, they should be subsequently destroyed.

In cleansing sponges after an operation, the following procedure

may be recommended. They are first thoroughly wrung out of cold water, and then placed to soak for a few minutes in a hot and strong solution of washing soda. They are then well rinsed in hot or cold water, or kept in running water, so as to remove all the soda, and finally immersed in a solution of carbolic acid (1 in 20), in which they are kept till required.

If swabs are used instead of sponges, they are made of absorbent wool wrapped up in a single layer of gauze, the ends of which are twisted up into a knot. A sufficiency of these of a suitable size is prepared before the operation, and they are purified in a dressing sterilizer. They are kept in the drum or box in which they were sterilized until required, and are thence removed by sterile hands or instruments to a suitable sterile receptacle, or are placed in lotion.

6 The ligatures and sutures, whether of catgut or silk, require very thorough purification. Silk needs to be boiled thoroughly for at least half an hour, and is then placed in carbolic lotion (1 in 20), it should be in loose coils, and not wound on a reel, as then only the outside strands are sterilized. Catgut, on the other hand, must not be boiled in water or immersed in carbolic lotion for too long, as it is apt to become rotten and break when used. It may, however, be boiled in cumol at a temperature of  $165^{\circ}\text{C}$  for an hour without harming it, it is then dried at a temperature of  $100^{\circ}\text{C}$  in a hot-air oven for two hours, and is transferred to sterilized test-tubes. Mayo Robson has advised the sterilization of catgut in xylol, which is kept at the temperature of boiling water for half an hour. A special metal cylinder with a screw top is required. The catgut is loosely wound on a reel or slide, and sufficient xylol is placed in the cylinder to cover the catgut, the top is then screwed down, and the cylinder is placed in a saucepan of cold water, which is gradually brought to the boil, and allowed to remain boiling for half an hour. The catgut is then removed, and kept in a 5 per cent carbolic solution in alcohol. Another simple and effective method is to place the catgut wound loosely on a glass reel firstly in ether for twenty-four hours, and then in a 5 per cent solution of formalin for a similar period, it is then immersed in boiling water for five minutes, and subsequently kept in a solution of corrosive sublimate, 1 part, glycerine, 250 parts, and methylated spirit, 1,000 parts. Various instrument-makers provide sterilized catgut in sealed glass tubes, Van Horn's catgut and suture materials can usually be thoroughly trusted.

7 The skin of the patient is shaved prior to operation if the part is hairy, and thoroughly washed with turpentine, soft soap and hot sterilized water, and some efficient antiseptic, it is then covered with an antiseptic compress—e.g., gauze or lint soaked in carbolic lotion (1 in 40) for some hours. When the patient is on the table and anaesthetized, a final cleansing is undertaken. The part is first well rubbed over with turpentine or ether to remove all fat and grease, and then washed again with soft or ether soap and hot sublimate lotion (1 in 2,000). It is then flushed with biniodide of



mercury in spirit (1 in 500) or with carbolic lotion (1 in 20), and finally the stronger antiseptic is washed away with a weaker solution either of carbolic acid or sublimate. It must not be forgotten that a very vigorous use of carbolic acid may be followed by local irritation, as well as by its absorption into the blood-stream, especially in protracted operations. Care must also be taken that the patient does not lie in a pool of antiseptic lotion which has run down during the washing and collected under the sacrum, many a bad antiseptic burn has resulted therefrom. Again, not only does the quality of the skin vary in different individuals (as may be illustrated by contrasting that of a coal-heaver, who possibly bathes once a year, with that of a child or lady, which is soft, clean, and delicate), but it also differs in various regions of the body, and hence the process of purification must be modified according to the character and thickness of the integument. Any part where dirt may accumulate demands scrupulous attention—*e.g.*, the umbilicus, external ear, toes, or corona glandis in persons with long foreskins. A word of warning is also needed as to the possibility of using a nail-brush too vigorously, leading to a traumatic dermatitis, or even waking up into activity germs which otherwise would have lain dormant in the deeper layers of the uninjured skin.

8 The area of operation is surrounded by mackintoshes, which should always be treated as more or less septic, and these in turn are covered with sterilized towels. The latter are by choice purified by boiling or by exposure to steam in a suitable sterilizer, but if desired they may be first soaked in a solution of carbolic acid (1 in 20), and then wrung out of a hot 1 in 40 solution, and kept warm until required. The objection to this latter plan is that the skin may be burnt if the patient has to lie on such a towel. Some surgeons prefer to use dry sterilized towels, but to our minds the wet are better, in that they cling closer to the skin and are less liable to slip. During an operation irrigation or flushing is unnecessary, unless the proceedings are prolonged, and then hot sterilized salt solution should be employed for the purpose, but a final flushing with carbolic lotion (1 in 40) or with sublimate (1 in 2,000) is advisable, especially when operating under conditions which are not ideal as to surroundings and technique. The objection to such flushing is that the lotion is more or less of an irritant, and determines a certain amount of subsequent oozing and effusion, which will necessitate drainage. More particularly, when dealing with the peritoneal cavity or interior of a joint, the less one employs antiseptics the better, they lead to desquamation of the delicate endothelial lining which it is so important to maintain intact. In fact, the rule of practice which we now insist on is *the strictest antisepsis for the external parts, but asepsis for the interior of the wound*. One cannot, however, always be certain that this ideal has been attained, and then irrigation with an antiseptic solution may be desirable.

9 Before closing the wound the surgeon must use every endeavour to secure absolute hæmostasis, and then the wound may usually be

stitched up completely and without drainage. In large wounds of vascular parts, and especially when some amount of oozing may be expected, it is advisable to insert a suitable drainage-tube, and stitch it flush with the surface. It is removed at the end of forty eight hours at most. We feel confident that the removal of the discharge and the changing of the soaked and perhaps stiffened dressings add materially to the comfort of the patient.

When the operation has been thus completed, the skin around is again cleansed with lotion, but *only after a piece of dressing has been placed as a protection over the wound*. This cleansing should always be accomplished by wiping peripherally away from the centre, and any sponge or swab which has been utilized for this purpose should not again be allowed to touch the wound.

Wounds communicating with septic cavities, such as the mouth or rectum, should be purified with a solution of chloride of zinc (40 grains to the ounce), and then powdered with iodoform, and either left open or lightly packed. Septic contamination is by this means delayed, and even when it does occur, it may be kept under control by frequent dressing and irrigation.

10 Finally, a carefully arranged Dressing is applied, and the part bandaged and placed at rest on a splint or in a sling, if such is indicated by the requirements of the case, absolute rest and quiet are essential if rapid healing is to be obtained.

As to the different forms of dressing, we must content ourselves with a few words as to those ordinarily employed. Lord Lister pointed out some years back that the main essentials of a good dressing consisted in its containing some trustworthy antiseptic ingredient, in this agent being so stored up that it cannot be dissipated before the next dressing, in its being entirely unirritating, and in the capacity of the fabric to readily absorb blood or serum that may ooze from the wound. The original antiseptic dressings, viz, the carbolic and eucalyptus gauzes, and even the alembroth gauze and wool, failed to fulfil these requirements, but in the double cyanide of mercury and zinc gauze we have a material which is to all intents and purposes perfect. It should be soaked for some hours in carbolic lotion (1 in 20), and may be applied to the wound without fear after wringing it out of a 1 in 40 solution. A sufficiency of this is employed so as to cover in a good margin of skin all round the wound, and, finally, over all a liberal covering of sterilized or antiseptic wool, so as to diffuse the pressure, which is applied by means of careful bandaging. The best material for bandages is butter-cloth, since it is light and adapts itself easily to the outlines of the part. Other dressings, such as boric lint, iodoform gauze, etc., are occasionally employed, but they are not so satisfactory for general use as the cyanide gauze.

Many surgeons employ simple sterilized gauze without any antiseptic ingredients, and where complete asepsis has been maintained and no subsequent discharge comes through, this will suffice admirably. We cannot, however, but feel that an antiseptic dressing is an extra

precaution that may be wisely adopted, and especially in cases where much discharge is expected. We would draw attention here to the fallacy of using sterilized cyanide gauze without soaking it in carbolic lotion, the object of the latter is largely to get rid of a certain quantity of irritating antiseptic which remains loose in the fabric, and unless washed out may give rise to an eczema of a very irritating character.

11 **After-treatment** —If no drainage-tube has been employed, and the dressing is not soaked through, it may be left untouched for seven or eight days, at the conclusion of which period it is removed, the stitches are taken out, and in all probability the wound will be completely healed. When a drainage-tube has been inserted, it is usual to take it out at the end of twenty-four or forty-eight hours, there is no advantage in retaining it longer, since it is only required for the removal of the sero-sanguineous fluid which exudes immediately after the operation. Should the discharge be very abundant and soak through the dressings, there is no need to remove them and re-dress during the first twenty-four hours, if the cyanide gauze has been employed, all that should be done is to damp the stained external bandages with 1 in 20 carbolic lotion, and then pack on some more gauze or wool. This may even, if necessary, be repeated a second time.

12 The **after-dressings** of the wound need to be conducted with the same precautions as to asepsis of hands, instruments, etc., as the original operation, and not a few instances of infection at the first dressing occur. It is essential that everything likely to be required should be prepared before the dressings are removed, so that exposure to the air may last as short a time as possible. If the first dressing is undertaken after twenty-four or forty-eight hours, and all is going on satisfactorily, the tube is removed, and the wound redressed in exactly the same way as formerly, though probably much less dressing will be required. If the case is left for eight days, the stitches can probably be taken out, and the surface will then be found united. A small dressing of cyanide gauze is applied, fitting closely to the scar, and sealed down with flexible collodion, which will not only prevent the gauze from slipping, but will also by its contraction serve to steady the parts. This may advisably be kept on for another week.

## CHAPTER XI

### HÆMORRHAGE

By the term *hæmorrhage* is meant any loss of blood, whether insignificant and immediately arrested by natural means, or more excessive and requiring treatment to prevent its continuance. Although most commonly due to some injury, whether subcutaneous or inflicted through the skin, it may be predisposed to by weakness of the vascular tissues, especially if associated with increased blood-pressure. Certain diseases, such as purpura and scurvy, are characterized by a tendency to bleeding, and there is one congenital condition, hæmophilia, in which it is difficult to stop the flow of blood when once started.

The character of the bleeding differs according to the vessel from which the blood escapes. **Arterial Hæmorrhage** consists in a flow of bright scarlet blood, which escapes at first *per saltum*, i.e., in jets synchronous with the heart's beat, and may be derived, not only from the proximal, but also from the distal end of the divided vessel, if the collateral circulation is sufficiently abundant. If, however, it is derived from a deep artery, the blood may well up from the depths of the wound and not escape in gushes. In **Venous Hæmorrhage** the flow is usually continuous, and the blood of a dark red or almost black colour. If, however, a large vein is wounded, such as the internal jugular, the blood may escape with a very definite spurt, owing to respiratory or other influences. **Capillary Hæmorrhage** is marked by general oozing from a raw surface, the blood trickling down into the wound, and filling it from below upwards. By **Extravasation of Blood** is meant the pouring out of blood from a wounded vessel or vessels into the lax areolar planes immediately adjacent, which become swollen and boggy. The usual constitutional signs will be manifested as a result of such extravasation, and, indeed, fatal hæmorrhage may occur in this way without any escape upon the surface of the body. Subcutaneous or submucous hæmorrhage is also met with in the form of small localized *petechiæ*, arising from injuries, or from changes in the blood or vessel walls (as in purpura, scurvy, and septicæmia). **Epistaxis** is the term given to bleeding from the nose. By **Hæmatemesis** is meant the vomiting of blood, it may either have been swallowed, as in some cases of

fractured base of the skull, where the pharyngeal mucous membrane has been torn, or it may have originated from the upper part of the intestinal tract. The blood is usually curdled and brownish in colour, somewhat resembling coffee-grounds, from the action of the gastric juice upon it. **Hæmoptysis** is the title given to the escape of blood from the air-passages, whether it results from injury or disease. **Hæmaturia** is a condition in which blood is passed in the urine. By **Melæna** is meant the passage of dark tarry blood with the fæces, it is always an evidence of disease or injury of the intestine sufficiently far from the anus to allow the blood to become altered in character by the action of the intestinal juices. Blood derived from the rectal mucous membrane usually retains its bright red colour.

**Constitutional Effects** — If the hæmorrhage is severe, as from division of a large artery, death results from syncope. The surface of the body becomes cold, clammy, and pale, the lips, ears, and eyelids are livid, the patient gasps, his respirations become quick and sighing, and death ensues after perhaps a few convulsive twitches of the limbs. If consciousness is retained at all, patients often complain of the sight failing, and a sense of increasing darkness, immediately preceding the fatal termination. These effects depend as much on the rapidity of the bleeding as on the total amount of blood lost, people can stand gradual loss of blood much better than when it escapes suddenly.

If the hæmorrhage is not so great as to kill immediately, the patient faints, and on recovering is in a condition of severe collapse and weakness, which continues for some time, he is also liable to recurrent attacks of syncope, any one of which may be fatal.

If the hæmorrhage is more gradual, but continuous, as in cases of piles or uterine fibroids, the patient becomes profoundly anæmic, and the lips, ears, and conjunctivæ are pearly white, dyspnœa ensues, owing to the insufficient amount of blood present, and in consequence the patient is extremely restless, tossing about in bed. Any sudden exertion, or even sometimes the attempt to sit up, is followed by a sensation of faintness, noises are heard in the ears, the sight becomes dim, or is even temporarily lost (amblyopia), and severe headache may be complained of, all arising from cerebral anæmia. The pulse often becomes what is known as *hæmorrhagic* in character, *i.e.*, frequent, large, and compressible, but collapsing entirely between each beat, and markedly dirotic. These peculiar features are due to the sudden passage of a small amount of blood through a vessel which is practically empty and entirely collapsed. From the defective *vis-a-tergo*, œdema of the extremities may result.

During the continuance of hæmorrhage the blood-pressure necessarily falls, but unless a volume equal to a third of the total bulk of blood in the body is lost, it quickly rises again to the normal after the bleeding has ceased. This rise in blood-pressure is partly due to a diminution in the size of the vascular area, owing to vasomotor contraction of the peripheral arterioles and of the splanchnic area, but is also caused by an increased flow of lymph into the circulation.

For the actual changes that occur in the blood as a result of hæmorrhage, see p. 44.

Children and elderly people alike bear the loss of blood badly, but whereas children rapidly recover from the immediate effects, elderly people do not.

**General Treatment**—When the loss of blood has been severe, the patient must be kept quiet with the head low, whether syncope is present or not. Stimulants may be necessary to maintain the heart's action, but should be given with discretion for fear of re-starting the bleeding. If death appears to be imminent, the arms and legs should be bandaged, or the abdominal aorta compressed, in order to confine the blood as much as possible to the head and trunk.

'No patient should be allowed to die of hæmorrhage.' Such was the dictum of the late Mr Wooldridge, of Guy's Hospital, based on a knowledge of the value of transfusion and infusion. By **Transfusion** is meant the transference of blood from one individual to another, it may be accomplished by two methods, the direct and indirect. *Direct or immediate transfusion* consists in injecting the blood of the donor directly into the vessels of the recipient. The objection to this method is that an individual can rarely spare sufficient blood to be of any real use, and hence the results are unsatisfactory. *Indirect or mediate transfusion* is carried out by whipping the blood from some healthy individual or individuals so as to remove the fibrin, and after straining through fine linen it is injected, either pure or diluted with saline solution.

During the last few years it has been recognised, however, that the *success* of this proceeding *depends on* the introduction of a sufficient *quantity* of fluid as a temporary substitute for the blood which has been lost, *rather than* on its *quality*, for it has been proved that the *transfused blood* of another person is rapidly destroyed and eliminated. Hence transfusion has now been replaced by what is known as **Infusion**, which consists in injecting large quantities of some bland fluid into the vessels, and by this means greatly improved results have been obtained. All the apparatus needed is a metal or glass cannula (Fig 72), the end of which is bulbous, blunt, and bevelled, which can be tied into a vein, and connected by means of a rubber tube with a reservoir containing the fluid (Fig 73). A vein, *e.g.*, the median basilic or internal saphena, should be exposed, tied below and opened by a longitudinal or oblique incision, the cannula, filled with lotion so as to exclude air, is then inserted, and a ligature placed round the vessel just below the bulb, so that on withdrawal it can be tightened. The amount injected varies with the circumstances and the effects produced, but, to be efficacious, some *pints* are usually needed, 4 or 5 pints have not uncommonly been employed for the purpose. As a rule, one injection is all that is required in dealing with hæmorrhage, but where shock is present it may need to be repeated two or three times.

As to the material, a warm saline solution is the best, consisting of a drachm of chloride of soda to a pint of sterilized water (or about

0.6 per cent), at a temperature of  $105^{\circ}$  to  $110^{\circ}$  F. The dried crystals of salt should be dissolved in a small quantity of boiling water, so as to sterilize it, and this is then diluted to the required bulk. Of course, the apparatus is most scrupulously purified, either by boiling for some minutes or by effective immersion in carbolic lotion, and no air must be admitted. The injection is made slowly, so that the solution may be gradually mixed with the blood. It has been found by experiment that after an infusion following hæmorrhage the specific gravity of the blood is only lowered for a very short period,

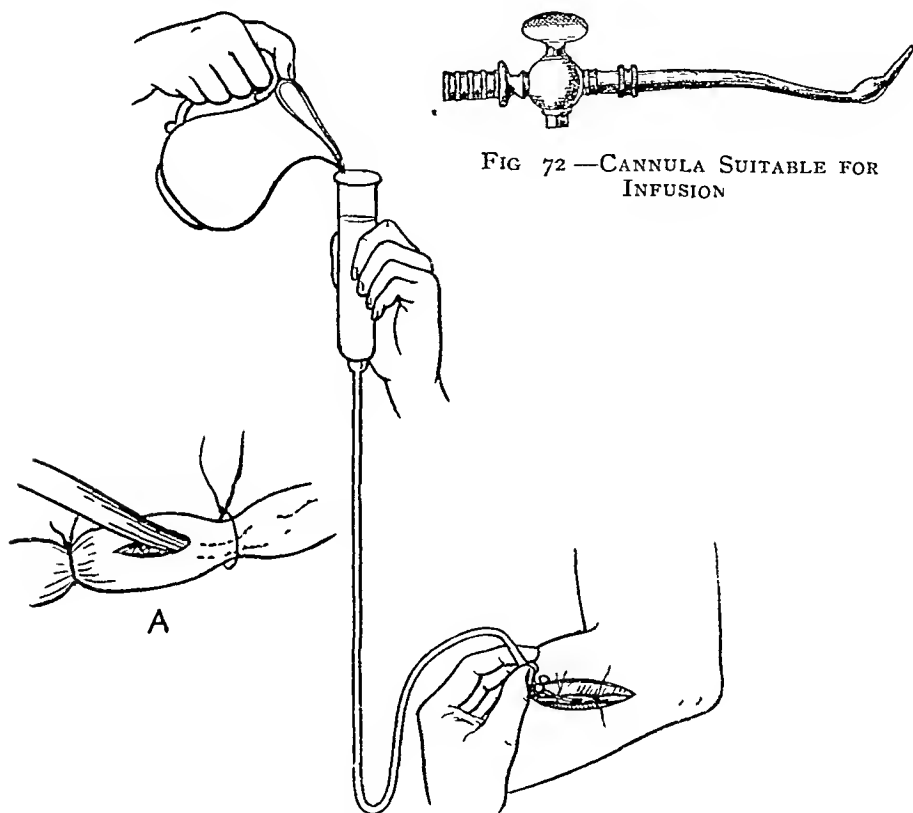


FIG 72 — CANNULA SUITABLE FOR INFUSION

FIG 73 — INFUSION INTO VEIN OF FOREARM

At A the arrangement of the ligatures around the vein is indicated

and rapidly rises to a normal level, or may even be raised above the normal. This suggests that the increased amount of fluid is sucked up by the tissues, and explains why it is sometimes necessary to repeat the injection more than once.

Another plan sometimes used with success consists in the introduction of warm fluid into the rectum, or through an aspirator needle connected with a tube and funnel into the loose connective tissue of the buttock, abdomen, or submammary region (*hypodermoclysis*). In the latter case the funnel must be held at some height (5 or 6 feet), in

order to gain sufficient pressure, and by this means a pint or more may be injected, a carefully sterilized syringe and a large needle may be employed for the same purpose. During the injection the part should be gently rubbed so as to distribute the fluid.

### Natural Arrest of Hæmorrhage

This can best be described under two headings, viz., (1) the temporary arrest, and (2) the permanent. The processes are much the same for arteries, veins, or capillaries, but since the arrest of arterial hæmorrhage has been more thoroughly investigated, and is the most important, we shall deal mainly with it.

The **Temporary** arrest of arterial hæmorrhage is brought about by three principal factors

(1) The **coagulation of the blood**, which occurs in and around the vessel, and without which death would ensue from the merest scratch. The greater the loss, up to half of the total amount of blood in the body, the more coagulable it becomes.

(2) **Diminution in the force of the heart's action** always follows hæmorrhage, from anæmia of the cerebral centres, a beneficent provision whereby coagulation is facilitated and the flow of blood checked. Unless the syncope is profound, stimulants should therefore be carefully avoided until the vessel has been efficiently secured, for fear of causing a recurrence of the bleeding by increasing the power of the heart's beat.

(3) **Changes in and around the vessel** play a most important part in completing the process. They consist in the **retraction** of the artery within its sheath by reason of its inherent longitudinal elasticity, if, however, it is only partially divided (or, as it is called, 'button-holed'), this condition cannot obtain, and the hæmorrhage is more likely to continue. As a result of this retraction, the rough and uneven inner lining of the sheath is exposed, and upon this the blood coagulates as it flows, thus gradually producing what is known as the **external coagulum**. At the same time the transverse muscular and elastic fibres in the vessel wall cause **contraction** of the open mouth, and thus, as the force and calibre of the blood-stream diminish, the external coagulum is able to increase in size by fresh deposits of fibrin, until at last its resistance is too great for the diminished cardiac impulse to overcome, and the sheath is filled with clot, which extends to the divided mouth of the vessel. From this an **internal coagulum** next develops, which sometimes extends upwards as far as the nearest patent branch. Thus the hæmorrhage is arrested for the time being, and preparation made for—

The **Permanent** closure of the wound in the artery, which merely consists in a modification of the general process of repair.

After the cessation of the hæmorrhage, the internal coagulum, soft in consistence and dark red in colour, extends from the mouth of the vessel, or from the site of the ligature, for some distance, and perhaps to the next collateral branch (Fig 74). The vessel wall contracts



upon this coagulum, with which, however, it does not unite, except at and near its base. As a result of the injury, a simple plastic arteritis is set up, evidenced by a hyperæmic condition of the vessel wall, due to dilatation of the vasa vasorum, and its infiltration with leucocytes, which also invade the coagulum and cause its base to become decolourized. The leucocytes break up the clot, traversing the natural lines of cleavage which result from its contraction, and gradually remove it, a few giant cells, probably derived from the leucocytes, occasionally assisting in this process (Fig 77). The tunica intima proliferates concurrently, causing a secondary infiltration with the larger fibroblastic cells in that part of the thrombus which is adherent to the vessel wall (Fig 76), whilst a growth of cellular buds or granulations, which gradually increase in size and encroach on the lumen of the vessel, springs up in those parts where



FIG 74 —EARLY STAGE OF OBLITERATION OF ARTERY AFTER LIGATURE

The thrombus is seen above and below the site of ligature, that on the proximal (upper) side being the larger commencing cell infiltration of the bases of the clots is also indicated

In both these diagrams the arteries have been represented of the same size throughout for clearness' sake in reality, the lumen would be much contracted



FIG 75 —LATER STAGES OF THE SAME PROCESS

The clots are shrinking, and the lowest portions are being transformed into granulation tissue. Proliferation of the tunica intima is also seen, reaching beyond the apices of the clots

the apex of the clot lies free and unadherent (Fig 75). Thus, the base of the clot is transformed into a cellular mass derived from proliferation of the tunica intima, and by the development of new vessels from the vasa vasorum into granulation tissue, whilst the cellular buds which grow from the walls, and extend nearly to the next collateral branch, are also similarly changed. The free conical extremity of the clot contracts, and is gradually removed, partly by the activity of leucocytes which infiltrate it from the base, partly by the erosive action of the surrounding granulation tissue. A similar set of changes occurs at the distal side of the ligature in an artery tied in its continuity, although the thrombus is smaller and less firm. The ligature itself may be infiltrated by leucocytes, and replaced by granulation tissue, or may be encapsuled. A rod of granulation tissue is

thus developed, blocking the vessel, and this, by the usual process of repair, is transformed into a firm cicatricial cord in the course of a few months (Fig 77) It must be clearly understood, however, that the presence of a coagulum is by no means essential to the obliteration of an artery Thus, if the walls are merely brought into close and accurate apposition by a ligature without dividing the inner or middle coats, a proliferative endarteritis without any clot formation results, which is quite sufficient for the occlusion of the vessel

The arrest of hæmorrhage from veins and capillaries is more easily accomplished, the collapse of the walls, together with the formation of the external coagulum, being sufficient for this purpose The later steps are similar to those occurring in an artery, except that there is but little internal coagulum In capillaries, unless some constitutional

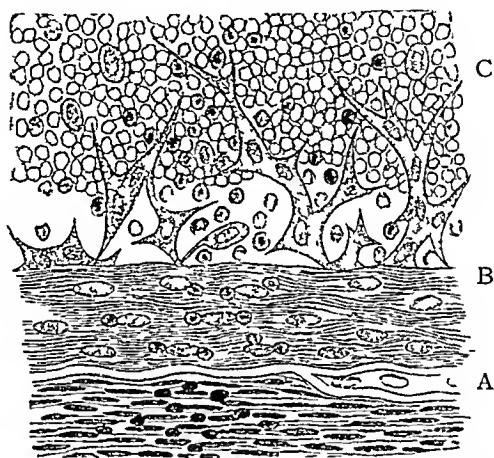


FIG 76 — EARLY STAGE OF ORGANIZATION OF THROMBUS, TO SHOW THE INFILTRATION OF THE CLOT WITH LEUCOCYTES AND CONNECTIVE-TISSUE CELLS DERIVED FROM THE ENDOTHELIUM (TILLMANN'S)

A, Tunica media, B, tunica intima, undergoing proliferative changes, and therefore thickened, C, blood clot lying in lumen of vessel becoming infiltrated with leucocytes (small dark cells) and larger fibroblasts derived from the endothelium

condition such as hæmophilia is present, the mere falling together of the walls is sufficient to allow coagulation to take place, and thus stop the bleeding

### Surgical Treatment of Hæmorrhage

Many different methods are needed, under varying circumstances, for the effective arrest of hæmorrhage It may be laid down as a preliminary axiom that digital pressure over the bleeding-point will always temporarily check the most furious outburst, whilst means for its permanent stoppage are being arranged

Where the bleeding, though profuse, does not come from any one particular vessel, the following measures can be utilized

1 **Cold** may be employed in the form of ice, cold water or lotion, or simple exposure to the air, all clots, rags, pledgets, etc., being removed for this purpose, it must, however, be remembered that ice and unsterilized water may convey sepsis. Such treatment is of most value for general oozing from vascular structures or into cavities, such as the mouth, vagina, or rectum.

2 **Position** — Where the bleeding is from one of the extremities, especially the lower, **elevation** is a most important factor in arresting it. The veins are emptied by the force of gravity, and this is always followed by a reflex contraction of the arteries, a proceeding of which surgeons avail themselves in order to exsanguinate a limb before applying a tourniquet in operations which one desires to render as bloodless as possible.



FIG 77 — ORGANIZED THROMBUS IN VESSEL, SHOWING THE NEWLY-FORMED CONNECTIVE TISSUE OCCUPYING THE LUMEN OF THE VESSEL, AND VASCULARIZED FROM THE VASA VASORUM (TILLMANN'S)

Two giant cells are seen in the centre

3 **Direct Pressure** — The skilful application of an antiseptic dressing, combined with pressure, is often effectual in arresting hæmorrhage. General oozing from cut surfaces, which can be brought into apposition, as from an amputation wound, may be checked by applying a firm bandage over them. In cavities or hollows, either natural or made by operation, bleeding may be stopped by plugging with strips of dressing, or by graduated layers of antiseptic wool. Such dressings should be retained firmly in position for twenty-four hours, after which, if no further hæmorrhage has occurred, the bandages may be slackened, but it is usually advisable to retain the deep-plugs for another day.

4 **Hot Water** (130° to 160° F) is a powerful hæmostatic. A certain proportion of carbolic acid or corrosive sublimate should be present to render the water aseptic, or it should have been previously

boiled. It is supposed to act by stimulating the involuntary muscular fibres of the vessel wall, but probably the coagulation of the albumen of the blood is an important factor, as unless the water is hot enough to blanch the surface of the wound, the bleeding is not stayed, but rather encouraged.

5 **Chemical Agents** may be used to check oozing from spongy parts, or bleeding from deep organs or cavities. If they are applied locally, and act primarily by causing coagulation of the blood, they are known as **Styptics**, or astringents. Such are the liquor ferri perchloridi or pernitratii, tincture of matico, tannic or gallic acids, alum, nitrate of silver, fibrin ferment, styptic colloid, cocaine, etc. If the drug is administered internally, and acts by increasing the coagulability of the blood, or by causing constriction of the vessels, it is termed a **Hæmostatic**—e.g., suprarenal extract (adrenalin), opium, ergot, turpentine, hamamelis, acetate of lead, chloride of calcium, etc. In applying a styptic, it is essential that the surface of the wound should first be thoroughly cleansed, and all coagula removed. A portion of the dressing dipped in the solution is applied to the surface, or the drug is sprinkled or sprayed upon it. The objection to most of these agents is that healing by first intention is often hindered, whilst in the case of perchloride of iron extensive sloughing may result. Probably the most powerful styptic is suprarenal extract, which, however, loses its virtues when kept in solution for more than an hour or two. One of the dried tabloids (grs. 5) may be dissolved in 2 drachms of a 5 per cent cocaine solution, and this is sprayed over the part, or applied on a piece of dressing.

6 **Cauterization** is not very largely employed for the arrest of hæmorrhage, except from bones and from tissues thickened by inflammation, where retraction and contraction of the vessels are difficult. It need in no way interfere with primary union if the skin is not touched, for the minute sloughs formed are quite aseptic, and will either be absorbed or cast off in the discharges. The chief objection to this method is the risk of secondary hæmorrhage when the sloughs separate. The cautery is sometimes used for the bloodless removal of vascular tumours, either as a galvano-cautery, a Pacquelin's knife, or the ordinary clamp and cautery. It must be remembered that, in order to effectually seal the mouths of the vessels, the cautery must be at a dull red or black heat; a bright red-hot iron cuts through a vessel as cleanly as a knife, and does not stop the hæmorrhage.

*When the bleeding is more serious, and originates from some definite vessel or vessels*, other and more vigorous measures have to be adopted. Digital pressure over or on the cardiac side of the bleeding spot suffices to arrest it for a time, whilst preparations are being made to ligature or otherwise treat the wounded vessel. If possible, a ligature should be applied with antiseptic precautions, but other means are used.

1 **Acupressure** was introduced by the late Sir James Simpson in order to obviate the use of ligatures. The introduction of aseptic absorbable animal ligatures has made such a method only necessary.

in exceptional circumstances. A needle is passed either under the vessel from the skin, or over the vessel from the surface of the wound, and, if placed accurately, is quite sufficient to stay the bleeding. With it, however, is sometimes combined the pressure of a-loop-of-silk or wire passed figure-of-8 fashion around the ends of the needle.

2 **Forcible pressure** is a plan of stopping hæmorrhage by crushing the divided end of the vessel between the strong and deeply serrated blades of a pair of forceps with scissor handles provided with a catch, those known by the name of Spencer Wells or Greig-Smith are the most convenient. In dealing with small vessels, it is quite sufficient to leave the forceps applied for a few minutes, perhaps twisting them before removal, but with the larger it is advisable to apply a ligature, although it is claimed for the Greig-Smith pattern that the artery is so thoroughly crushed that this is unnecessary. In deep wounds, where it is difficult, or almost impossible, to tie the vessel, the forceps may be incorporated in the dressings, and not removed for twenty-four hours.

3 **Torsion** was used as a means of sealing the ends of divided vessels before aseptic ligatures were introduced. It may be applied in two ways—viz, (a) **Limited Torsion**, which is employed for the larger vessels. The artery is drawn out of its sheath for about half an inch with one pair of forceps, and held close to the tissues by another pair applied transversely, whilst the grasped end is twisted sufficiently to thoroughly close it, it should not, however, be twisted off. (b) **Free Torsion** is used for the smaller vessels, which cannot be so completely isolated from surrounding structures, the vessel is laid hold of with its sheath or connective-tissue covering, and twisted as much as necessary.

The effect of torsion is that the inner and middle coats are ruptured just above the spot grasped, and tend to curl upwards into the lumen of the vessel, whilst the outer coat is twisted up beyond. A coagulum forms upon the injured structures, and the subsequent processes to secure permanent occlusion are similar to those described above. Torsion is employed occasionally in plastic work, and in twisting off small vessels previously secured by forcipressure forceps.

4 **Ligature** is at the present day the method most frequently used for arresting bleeding from a definite source.

The material should be of sufficient strength to secure the vessel, of sufficient resistance to maintain its hold in spite of being soaked in the body fluids, and yet of such quality as to be finally absorbed, or so pure and unirritating as to become encapsuled in the tissues. Catgut suitably prepared is the substance most frequently employed, but inasmuch as commercial catgut, even when rendered aseptic by immersion in carbolic acid, swells up in warm blood serum, and becomes a soft, pulpy mass in half an hour, it is necessary to harden and render it more resistant by steeping it in a solution of chromic acid, and subsequently in a sulphurous acid solution. It is then dried, and is of a greenish colour. It must not be forgotten that catgut is prepared from sheep's intestines, by allowing the latter to

putrefy in water and then scraping away the mucous and muscular coats, leaving only the submucous tissue with its elastic fibres, which is twisted up into long strands. It is obvious that very efficient sterilization is necessary to make a material thus prepared fit for surgical work (p 267). The length of time that catgut will remain unabsorbed in the tissues varies with the period of its immersion in chromic acid, and material calculated to last ten, twenty, thirty, or forty days can be obtained in a sterilized condition from instrument makers. Van Horn's preparations are particularly reliable.

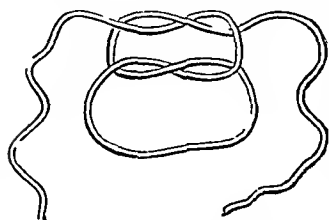


FIG 78 —REEF KNOT

Sterilized silk is another agent employed, whilst animal tissues, such as kangaroo tendon and strips of ox aorta, have their advocates. Ballance and Edmunds advise the use of gold-beaters' skin, prepared from the peritoneum of the ox, as a material for tying vessels in their continuity, and excellent results have followed its employment. Pagenstecher's celluloid ligature may also be considered a safe and harmless material, and can be sterilized by boiling.

Ligatures may be applied either to the divided end of an artery in an open wound, or to an artery in its continuity, the effects and final means of occlusion being in both cases very similar.

When applied to the open end of a divided vessel, care should be taken to select a ligature the thickness of which is proportionate to the lumen of the vessel to be tied. The artery should be cleanly picked up with forceps, so as to include as little surrounding tissue as possible, and where a sheath exists, should be withdrawn from it. The ligature is then passed round it and tied in a knot which will not slip, *e g*, the reef knot (Fig 78). When the application of a ligature is difficult, as in very dense fibroid tissue, it may be advisable to pass it under the vessel by means of an ordinary curved needle, and then to tie it.

For *ligation in continuity*, see p 326.

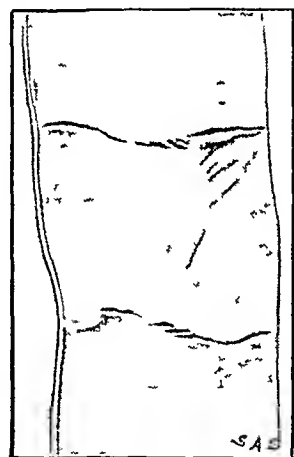


FIG 79 —EFFECT OF TYING A LIGATURE FIRMLY AROUND AN ARTERY

The ligature was tied at two levels, and the artery then laid open longitudinally.

**Effects of Ligature—1 On the Vessel Wall**—The immediate result, if the vessel has been tied in the usual way, is to divide the inner and middle coats, which are separated from the outer and curl up slightly, whilst the outer coat is constricted and thrown into folds within the grasp of the ligature (Fig 79). If an artery is tied in its continuity, the same effect is produced on each side of the ligature. The changes already described, by means of which the artery is obliterated and transformed into a fibro cicatricial cord,

then manifest themselves in due order. An exudation of plastic lymph and cells occurs into the sheath and around the ligature, and if the latter is aseptic, the whole is embedded in this plastic mass, which undergoes the ordinary changes seen in repair. If the ligature, however, is *septic* and irritating, it has to cut its way out through the vessel wall by an ulcerative process akin to the separation of a septic slough, thus exposing the patient to the risk of secondary hæmorrhage from the disintegration of the internal coagulum. The period at which a septic ligature is separated varies with the size of the vessel, from a week or eight days for an artery the size of the radial or ulnar to twelve or fourteen days for the subclavian or carotid.

Division of the inner and middle coats is not to be considered an essential element in gaining satisfactory occlusion of a vessel, for it can also be effectively accomplished by merely bringing the vascular tunics into close apposition with a broad animal ligature applied by what is known as a 'stay knot' (p. 327), without harming the tunica intima. This plan may be adopted advantageously (1) when the artery must be tied at a spot where it is obviously diseased, or (2) in dealing with arteries of great size, such as the innominate, the first part of the subclavian, or the common iliac, the non-observance of this precaution results in aneurismal dilatation at the point of ligature, and this in secondary hæmorrhage and death. On the other hand, it would seem safer to apply a ligature firmly on the main trunk in an amputation stump, since the division and curling up of the inner and middle coats must facilitate the deposit of fibrin and process of repair.

All arteries in the body are maintained more or less upon the stretch, and hence retract within the sheath on complete division. A certain amount of longitudinal tension must therefore always exist upon any part of an artery to which a ligature has been applied in its continuity, and this may presumably predispose to secondary hæmorrhage. To obviate this, it has been suggested that two ligatures should be applied, and the vessel divided between them. This plan may be used with advantage in situations where the artery is easily accessible, but is scarcely feasible in some of the deeper operations.

2 The **Ligature** itself undergoes changes, which result in its partial or total absorption, if such be possible, or in its becoming encapsuled if absolutely unabsorbent. The leucocytes attack any soft material, such as silk or catgut, insinuating themselves amongst the fibrillæ, and finally remove them by a similar digestive process to that which leads to the absorption of a small aseptic slough. Multinucleated giant cells are often present, and probably take some part in the proceeding. Finally, every trace of the ligature disappears, and its place is taken by fibrous tissue, incorporated with that arising from the end of the vessel. Chromicized gut, as already explained, lasts a variable time according to its method of preparation, silk is removed, but slowly. Other animal substances employed are dealt with in the same way, and even silver wire is not unaffected, its surface becoming roughened after a time and slightly eroded.

3 The effect on the **Circulation** is the same whether ligature or any other plan of occlusion is adopted. The passage of the blood through the vessel ceases, and its proximal end as far as the next patent branch soon begins to contract, though remaining somewhat distended for a short time by the impact of the blood-stream. It is ultimately converted into a fibrous cord, which may or may not be pervious for a short distance. Blood is conveyed to the vessels of the limb below the ligature by anastomosing branches, which rapidly undergo dilatation and establish a *collateral circulation*, sufficiently free as a general rule to maintain the vitality of the part. These collateral branches become permanently enlarged, lengthened, and tortuous, and their walls thickened. If for any reason the collateral circulation is insufficient, gangrene is likely to supervene, starting in the parts furthest away from the centre of the circulation, or in the structures of least vitality (*e g*, the fingers, toes, or sub-cortical white substance of the brain), and spreading backwards until a part is reached which receives enough blood to keep it alive.

### Arterial Hæmorrhage

Three forms of arterial hæmorrhage are described, viz, primary, reactionary, and secondary.

**Primary Arterial Hæmorrhage** is met with under two conditions—from an open wound, or where an artery is ruptured or punctured subcutaneously, so that extravasation into the tissues occurs, constituting either a severe bruise if the artery is small, or if the vessel is large what has been badly termed a ‘diffuse traumatic aneurism’. The general rules for the surgical treatment of both these conditions are identical, and although the agent employed to finally arrest the bleeding varies according to the surgeon’s personal predilections, yet the underlying principles hold good in all cases. We shall limit ourselves to speaking of the ligature.

A **Primary arterial hæmorrhage from an open wound**. The blood is here poured forth upon the surface, and escapes freely, so that the full constitutional effects are experienced.

The *principles* that guide us in its **Treatment** may be enunciated as follows.

1 *That the vessel must be secured at the bleeding-point*, an operation to expose it being undertaken if necessary. However infiltrated the part, the rule of cutting down to expose the wounded vessel is to be adhered to, with one or two exceptions noted below, and this for two reasons. (a) It is often impossible to know the exact source of the hæmorrhage unless it is laid bare. Thus, the bleeding from a punctured wound of the front of the leg, which was apparently derived from the anterior tibial artery, was proved on incision and careful dissection to come from the peroneal, the wound extending backwards between the bones. In the axilla and groin such uncertainty often exists. (b) Proximal ligature of a vessel at some distance above the bleeding spot is commonly insufficient to arrest the



hæmorrhage, since the collateral circulation is quickly established, and then reactionary hæmorrhage is very likely to ensue

2 *That both ends of the wounded vessel must be secured* if it is completely divided, whilst if it is only punctured, a ligature must be placed on each side of the puncture, and the complete division of the vessel effected. The ease with which collateral circulation is established justifies such treatment in the case of all arteries of large size. Thus, where the facial artery is divided, jets of blood are emitted from each end quite freely, and with nearly as much force from the distal as from the proximal. Occasionally the distal end of a bleeding vessel retracts amongst the infiltrated tissues to such an extent as to render its isolation impracticable. The surgeon must then trust to plugging of the wound from the bottom, but not until every effort has been made to secure it.

It is only needful to undertake the measures detailed above in cases where primary hæmorrhage is actually proceeding. If it has been once arrested, it is unnecessary to search for the bleeding spot unless the patient is very faint and collapsed, and the surgeon has reason to anticipate that a large trunk has been injured. Under such circumstances it may be needful to seek for and tie it at once, otherwise recurrent hæmorrhage is likely to ensue when the heart's action becomes more vigorous.

There are a few exceptions to the general rule of tying a wounded vessel at the injured spot, *e.g.*, where the depth of the dissection might endanger important parts, as in dealing with the deep palmar and plantar arches, or with the secondary branches of the carotid.

In the actual treatment of any particular case, *temporary arrest* of the bleeding may usually be effected by *digital compression* either of the bleeding-point or of the main trunk at a favourable spot nearer to the heart, against some resisting structure, such as a subjacent bone. The *common carotid* is controlled by grasping the neck from behind, and compressing the artery by the fingers placed along the anterior border of the sterno-mastoid against the transverse process of the sixth cervical vertebra (Chassaignac's tubercle). Such pressure will also control the vertebral and inferior thyroid vessels. The *subclavian* is to be compressed in the third part of its course against the first rib by the finger or thumb placed immediately behind the clavicle, the palm of the hand resting over the shoulder. A good deal of force is required in order to maintain the pressure, and this may be gained by superimposing the fingers or thumb of the other hand. Where the pressure is to be kept up for some time, the handle of a doorkey well padded may be employed in the same way, or an incision may be made and the vessel exposed, and directly controlled by digital pressure. The *facial* artery is compressed against the lower jaw just in front of the masseter muscle. Bleeding from the *labial* and *coronary* arteries is commanded by inserting the index finger into the corner of the mouth, and compressing the lip between it and the thumb outside. The *temporal* artery should be compressed against the zygoma just in front of the ear, the *occipital* at a spot

about  $1\frac{1}{4}$  inches from the occipital protuberance against the superior curved line. To control the *brachial* artery, the arm should be grasped from behind, and the fingers pressed inwards along the inner margin of the biceps against the humerus. The *radial* and *ulnar* arteries are easily commanded above the wrist by using both hands to grasp the forearm, with a thumb on each vessel. The *abdominal aorta* is temporarily controlled in slim individuals with ease by pressure through the abdominal wall against the body of the third lumbar vertebra at a point a little above and to the left of the umbilicus, *ie*, just above its bifurcation, in stout persons this is impossible. The *common femoral* artery is best compressed just below Poupart's ligament. The surgeon should stand on the same side of the patient as the artery to be controlled, and use either the fingertips or thumbs to press the vessel directly backwards against the pubic ramus. The fingers of one hand placed over the other may sometimes be necessary to maintain sufficient command, or the thigh may be encircled by the two hands, and one thumb laid over the other. Care must be taken not to let the vessel roll aside, and so escape compression. When the artery has to be controlled for some time, as in an amputation, the hands may be used alternately, the one to rest the other. Such pressure will suffice for the temporary arrest of hæmorrhage from any part of the lower limb. If it is desirable to control the *anterior and posterior tibial* arteries close to the ankle during operations upon the foot, the assistant who steadies the limb accomplishes this by grasping the toes with one hand, and with the other compressing the vessels, the posterior tibial at a spot a finger's breadth behind the internal malleolus, the anterior midway between the two malleoli.

As digital compression cannot, however, be comfortably maintained for long, *mechanical compression* of a limb, as by tourniquet or elastic bandage, must be requisitioned. Possibly the screw tourniquet will be the best to apply, as it can be relaxed and tightened again as often as is necessary during the operation. In some cases it is advisable to exsanguinate the limb by elevation before applying the tourniquet.

The wound is then, if need be, enlarged by incisions, which, whilst laying the parts freely open, should inflict the least possible damage on surrounding structures. All coagula are removed, and the wounded vessel looked for. It may be needful to relax the tourniquet, and allow a jet of blood to escape, in order to ascertain its position. Both ends should be sought for and tied, a proceeding easier said than done. This especially applies to the distal end, which retracts, and often does not bleed at the time of operation, but may do so when the collateral circulation becomes established.

B For **Subcutaneous Rupture of an Artery**, see p 293

### Recurrent, Intermediate, or Reactionary Arterial Hæmorrhage

Such are the terms applied to bleeding which recurs within twenty-four hours of an accident or operation. It is an evidence of the failure of the means employed to arrest permanently the primary loss of blood, and may result from two chief causes (a) Defective application of a ligature, which comes undone from being badly tied (a 'granny' knot), or slips off from including within its grasp other structures as well as the arterial wall, or (b) the coagula lying in the mouths of divided vessels are not sufficiently firm to withstand the increasing blood-pressure which supervenes after the shock has passed away, or which may be due to excitement or the injudicious administration of stimulants. It is usually due to the second of these causes, and is then not very serious, inasmuch as it can only arise from the smaller vessels, all the larger ones having probably been recognised and tied during the operation.

**Treatment**—Elevation and the pressure of a firm bandage are often quite sufficient to arrest this form of bleeding, but if unsuccessful, the wound must be opened up, washed out with hot or cold lotion, and any bleeding vessel tied. The actual cautery may even be employed to check oozing from cicatricial surfaces, and if it is not allowed to touch the skin, and the wound kept aseptic, no delay in its healing need be occasioned. Should the bleeding persist, the wound should be firmly packed.

### Secondary Hæmorrhage

Under this title are included all forms of hæmorrhage from wounds which occur after the lapse of twenty-four hours. It is usually due to sepsis, and was formerly very common, often leading to a fatal termination, but since the introduction of antiseptic surgery it is but seldom seen. Where antiseptics, however, cannot be efficiently carried out, as in the mouth, pharynx, etc., it is still occasionally met with.

The **Fundamental Cause** in the production of secondary hæmorrhage is without doubt a **septic condition** of the wound. This may act in various ways. Thus, in a vessel entirely divided, the cocci may gain entrance through the open mouth to the internal coagulum, and by causing its disintegration, break down the barrier which Nature had raised against such an occurrence. This process is assisted by an ulcerative form of peri-arteritis, which leads to the maceration and softening of an absorbent ligature, and to weakening of the vessel walls. It is in this latter way that secondary hæmorrhage is induced in vessels ligatured in their continuity, the loss of support due to the opening up of the septic wound being also an element of danger. We desire here to emphasize the marked alterations in all the conditions existing in a septic as opposed to an aseptic wound. In the latter it is not only the clot in the lumen of the vessel which is relied on to prevent accidents, but the vital action of all the tissues is calculated to work in the same direction, that of insuring the patient against hæmorrhage, in fact, the occurrence of secondary

hæmorrhage in an aseptic wound is almost impossible. On the other hand, when sepsis supervenes, a destructive process replaces that of repair, and the activity of the part is temporarily paralyzed by the toxic influence of the micro-organisms and their products.

Various other conditions may be mentioned, however, as **Contributory Causes** of secondary hæmorrhage. (i) The ligature may be coarse, irritating, or septic, or it may consist of material too readily absorbed. (ii) Its mode of application may be faulty. Thus, it may have included other structures, and so becomes loose, offering an insufficient bar to the blood-pressure, or the sheath may have been opened too freely, and thus the vitality of the vessel wall dependent on the vasa vasorum is diminished. In large vessels, such as the innominate and first part of the subclavian, the mere division of the inner and middle coats weakens the wall to such an extent as to render it incapable of withstanding even a normal blood-pressure, so that aneurismal dilatation and secondary hæmorrhage are almost certain to result, even in aseptic cases. (iii) The ligature may have been placed too near a branch immediately concerned in the establishment of the collateral circulation (though if asepsis is maintained this is comparatively unimportant), or where there is a considerable back-flow, or the part may not have been kept absolutely at rest. (iv) The condition of the arterial wall at the site of ligature may be unhealthy, being possibly the seat of atheroma or fatty degeneration, a most important complication if the wound becomes septic. (v) The state of the blood may be unfavourable to the repair of any wound, whether in an artery or not, e.g., in albuminuria or diabetes. (vi) Increased blood-pressure after the ligature of a vessel may lead to secondary hæmorrhage, as in plethora, Bright's disease, traumatic fever, or from injudicious excitement or the unwise administration of stimulants.

The **Phenomena** are usually preceded by those of septic contamination of the wound, to which a slight occasional loss of blood is added. This continues with more or less frequency and severity, until the patient is either worn out by the constant repetition of small losses, or destroyed by one or two severe gushes from the larger vessels. The earlier the bleeding occurs, the less serious it is, as it probably comes from the smaller vessels, and can be easily dealt with. When, however, it does not supervene till late, as on the tenth or twelfth day, it usually arises from the larger trunks, and is increasingly severe. When originating from a vessel tied in its continuity, it generally comes from the distal end, and that for the following reasons: (a) The internal coagulum is here less firm, and forms later than at the proximal end, (b) the pressure at the distal side of the ligature, which is at first nil, is continually increasing as the collateral circulation is established, whilst proximally it gradually diminishes as the vessel contracts, and the blood-flow is deflected into other channels, and (c) the main vasa vasorum always run into and along the vessel wall in the same direction as the blood-stream. Hence the effect of isolating the artery in its sheath and ligating it is to

diminish the vitality of the arterial tunics just below the point of ligature, and thus unduly expose this part to bacterial activity

The **Treatment** is a matter of grave anxiety until the wound gets into a healthy state, inasmuch as the surgeon can never be certain that the bleeding will not break out again, although it may have been temporarily stayed, hence such a case must be most carefully watched. If the wound is in a limb, a tourniquet should be lightly adjusted above it as a precautionary measure, so that at a moment's notice it may be tightened.

When arising *from an artery entirely divided across*, as in an amputation stump, elevation of the part, exposure to the external air, bathing it with cold lotion, and then re-dressing and firmly bandaging it, may be all that is needed in the early and mild cases. A recurrence will necessitate the opening up of the wound, and the application of ligatures to the bleeding-points, if practicable. The actual cautery may be employed where the tissues are too rotten to hold a ligature. Means should be adopted to remove septic sloughs, as by a Volkmann's spoon, and if possible to render the wound aseptic by swabbing it out with strong carbolic lotion (1 in 20), or with a solution of chloride of zinc. The wound should then be powdered with iodoform, packed with cyanide gauze, and firmly bandaged. If occurring later in the case, the wound should be freely opened, and an attempt made to secure the bleeding vessel by isolating it for some little distance from surrounding structures. If this fails, owing to the sloughy or septic state of the tissues, the artery must be tied just above, or re-amputation performed. When the bleeding comes from the main vessel near the trunk, as after amputation at the shoulder or hip, proximal ligature can alone be depended on, should local treatment be unsuccessful.

When coming *from an artery tied in its continuity*, the means indicated above should be adopted in the early stages. Later on, the treatment varies a little according to the situation. If from a vessel of the *trunk*, such as the carotid or iliac, the wound must be freely opened up, and the artery secured again above and below, whilst every effort is made to combat the septic condition by plugging with antiseptic materials. Failing this, if proximal ligature is impossible, one can only trust to pressure. In the *arm*, after using cold, pressure, and elevation, one would re-tie above and below through the original wound. If this fails, a ligature should be applied higher up through a separate incision, or finally amputation be performed. In the *leg*, however, it is scarcely wise to attempt re-ligature at a higher spot, owing to the less abundant collateral circulation. If the hæmorrhage ceases, gangrene is very likely to ensue, whilst if the latter does not supervene, hæmostasis will probably not be effected. Under such circumstances amputation must be undertaken without delay.

### Venous Hæmorrhage

Bleeding from the smaller veins rarely requires much attention, in that the walls, when once divided, rapidly collapse, and this effectually checks further loss of blood, but if the larger veins are involved, or if the walls are thickened and rigid, as in varix, a very considerable amount may be lost, the blood welling up in a dark, purplish stream from the wound, and rendering its arrest the more difficult from the fact that, except in veins of the largest size, there is no definite jet or gush to guide one to the wounded spot

**Treatment of Venous Hæmorrhage**—The same means to a large extent must be employed as for arterial hæmorrhage, but it is less frequently required, since the smaller veins collapse naturally, and thus the bleeding stops. It is seldom advisable to occlude the whole circumference of a large vein if it can be avoided, since a puncture or tear can often be secured without seriously encroaching upon the calibre of the tube. In amputations it is usual to tie both the main artery and vein. Where it is difficult to reach a vein in order to tie it, the wound may be stuffed.

The dangers of venous hæmorrhage are fourfold (1) The constitutional symptoms arising from the actual loss of blood, details of which have been given above, (2) the thrombus which forms may become displaced as an embolus, (3) septic infection of the thrombus lying in the mouth of the vessel may lead to pyæmia, and (4) the **entrance of air into veins**, which, though rarely met with, is fraught with the most urgent danger to the patient. The air becomes churned up in the cavities of the right side of the heart, forming a spumous, frothy mixture amongst the columnæ carneæ, which the heart can only with difficulty eject, thus the circulation is brought to a standstill in spite of forcible cardiac contractions, and the patient dies from anæmia of the lungs and brain.

The **Cause** of the entry of air is usually a wound of some vein in what is known as the 'dangerous region' of the neck or axilla; or even of such unlikely structures as the pelvic veins or cranial sinuses. There is but little blood-pressure within the veins at any time, but during inspiration the movements of the thorax exercise an aspiratory or suction effect upon the blood in the veins of the neck, a most important element in the maintenance of the venous flow. Any condition which tends to prevent the collapsing of the walls of the veins, or brings about what is termed their **canalization**, predisposes to this accident. Thus they may be held open at spots where they pierce the deep fascia or the platysma, if the coats are thick and rigid from inflammation, or surrounded by indurated tissue, or button-holed as by excision of a portion of the walls or division of a branch close to the main trunk, or if undue traction is exercised upon the pedicle of a tumour containing a wounded vein, then the orifice may remain patent, and air can be sucked in. If, however, the veins are very distended, and the intravenous pressure high, as is often seen in the

operation of tracheotomy, then the wound of a vein, even in the dangerous area, usually results in loss of blood rather than entrance of air

**Signs**—The entrance of air into a wounded vein is accompanied by a hissing, gurgling, or sucking sound, which is quite characteristic. A few bubbles of air may also be seen clinging about the aperture in the vessel. If only a small amount has entered, or if the entry is made slowly, no bad results may follow, but the usual effect of the sudden introduction of even a small quantity is to produce severe faintness, and if the patient is conscious, a feeling of dyspnoea and distress, which is partly cardiac in origin, partly due to obstruction to the flow of blood through the lungs. The pulse becomes rapid and almost imperceptible, the pupils widely dilated, and death usually follows, preceded perhaps by convulsions, although the fatal issue may be postponed for a few hours. If the patient survives, no after-effects remain.

**Treatment**—This accident can usually be avoided by dealing cautiously with all veins in operations about the neck. Should it occur, any fresh entrance must be at once checked by placing a finger over the bleeding-point or pouring lotion into the wound. The vein should be secured by ligature as soon as possible. Compression of the chest has been recommended by some authorities in order to squeeze out the air that has entered, but there is little chance of attaining this end. To combat the general symptoms, it is essential to maintain a good supply of blood to the brain. The head is lowered, and, if need be, the limbs raised and bandaged, or the abdominal aorta compressed. Stimulants and artificial respiration are used in order to maintain the heart's action and to overcome the pulmonary obstruction. Warmth and friction are also applied to the extremities.

### Capillary Hæmorrhage

This is usually of little significance. It is characterized by a general oozing from the wounded surface, the blood trickling down to fill the cavity from the bottom. It is often very abundant from inflamed parts, and especially from fibro-cicatricial tissue, which prevents the closure of the vessel mouths. It can usually be arrested by a little pressure, or by the application of cold or hot water, by styptics, cauterization, or plugging.

### Methods of Dealing with Hæmorrhage from Special Sources

**Carotid Artery**—Treatment is impossible unless the surgeon is on the spot, when both ends should be tied.

**Jugular Vein**—Tie, or stitch, if possible, without occluding the whole lumen.

**Secondary Branches of the Carotid**—It may be difficult to secure the divided ends of these vessels either in the neck or head, e.g., in a cut throat or a punctured wound of the pterygoid region. Under such circumstances, ligature of the external carotid between the superior thyroid and lingual has been recommended as more satisfactory than tying the common carotid, since the cerebral circulation is not thereby affected.

**Vertebral Artery**—The source of such bleeding may be difficult to ascertain, as it is scarcely possible to compress this vessel without also including the carotid, and hence mistakes in diagnosis have often arisen. It may be feasible, however, to control the carotid alone by pinching it up by the fingers placed on either side of the sterno-mastoid, without interfering with the vertebral. *Treatment* must follow the usual course of cutting down and tying at the bleeding-point, if possible. To do this, the incision must be enlarged, or a new one made along the posterior border of the sterno-mastoid in order to define the transverse processes of the vertebræ. In the upper part of its course the vessel may be secured by clipping away a transverse process if necessary, due care being taken of the nerve roots, other wise, plugging of the vertebral canal or the use of styptics must be depended on. It is most essential that the carotid should not be tied by mistake in these cases, as thereby more blood is directed to the vertebral trunk, and the bleeding is correspondingly increased.

The **Internal Mammary Artery** rarely calls for treatment, since a punctured wound of this vessel is usually complicated with some graver mischief to heart, liver or lungs. If recognised, tie at the bleeding spot, possibly removing a costal cartilage to gain access. The vessel lies about  $\frac{1}{2}$  inch outside the border of the sternum.

**Intercostal Hæmorrhage** usually results from penetrating wounds also involving the rib, and is not easily stopped on account of the position of the vessels in the groove. *Treatment*—Incise the periosteum longitudinally along the lower border of the rib, and detach it and the vessels from the groove, or remove a portion of the bone, and thus expose the bleeding-point, or in some cases a suture passed round the rib a little above the injury has sufficed, or again, pressure may be employed by pushing a piece of aseptic gauze, like a pocket, through the wound into the pleural cavity, and then stuffing it tightly with wool or strips of gauze, so that on pulling upon it the vessel may be effectually compressed.

Wounds of the **Vessels of the Extremities** need treatment according to the principles enunciated above. Only one or two require special mention.

Wounds of the **Palmar Arches** were formerly much more dreaded than they are at present, when thorough antiseptics and the use of the elastic tourniquet allow us to explore the depths of a wound without much danger or difficulty. The position of the wound will usually indicate whether the bleeding comes from the superficial or deep arch, but in case of doubt it is well to remember that pressure on the ulnar trunk mainly affects the superficial arch, whilst pressure on the radial will chiefly influence the deep. A wound of the superficial arch presents little trouble in treatment, as it can be readily secured by catch forceps and ligature, but the deep arch is not so easily dealt with. It lies just over the bases of the metacarpal bones (Fig 80, D), and to expose it the wound must be freely enlarged by a longitudinal incision, and the tendons turned on one side or separated. It may be possible to secure the vessel by forcipressure forceps, and these may be left on for twenty-four hours if a ligature cannot be applied. Of course, the strictest asepsis is needful in such cases, and passive movement of the fingers must be early undertaken, in order to prevent troublesome adhesions.

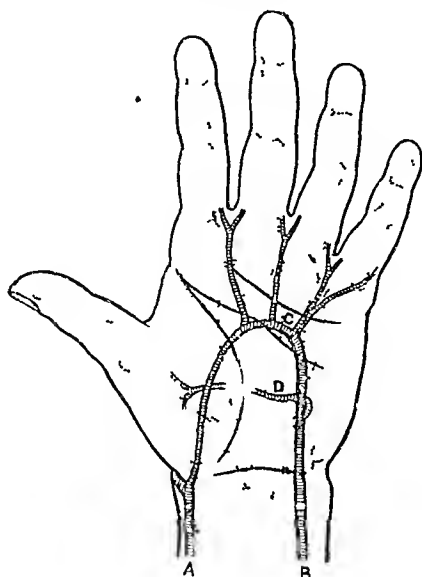


FIG 80—HAND TO SHOW POSITION OF PALMAR ARCHES

A, Radial artery B, ulnar artery, C, superficial arch, D, deep arch



Failing such means, or in septic wounds, the wound is carefully plugged with gauze, and over this the fingers are firmly bandaged. The patient is kept in bed for a few days, and the arm elevated. Pressure on the main vessels above is scarcely necessary if the compress is accurately applied. The bandages may be relaxed at the end of twenty-four hours, but the deep dressing should, if possible, not be touched for three or four days. If, in spite of this, bleeding recurs, the main vessel or vessels of the limb must be tied. Ligature of the ulnar and radial at the wrist is generally insufficient to control it, as there is often a communicating branch of some size passing from the anterior interosseous to the deep arch, and hence it may be needful to secure the brachial artery, ascertaining first, however, by pressure that such would be efficacious, for occasionally there is a high division of the brachial; or a vas aberrans may exist, which would compel the surgeon to tie the third part of the axillary.

Bleeding from the **Plantar Arch** must be conducted on similar lines.

The **Gluteal, Sciatic, or Pudic** arteries may be wounded by stabs in the buttock. *Treatment*—Enlarge the wound in the direction of the fibres of the gluteus maximus, *i.e.*, downwards and outwards, and secure the bleeding vessel. The gluteal trunk emerges from the pelvis at the junction of the middle and inner thirds of a line from the posterior superior iliac spine to the great trochanter, the pudic crosses the ischial spine at the junction of the middle and lower thirds of a line from the posterior superior iliac spine to the tuber ischii. The sciatic emerges from the pelvis just above and a little external to the latter spot. The pudic may also be divided in the perineum by a penetrating wound. Failing ligature of any of these arteries at the seat of bleeding, the internal iliac may need to be secured.

### Hæmophilia

By hæmophilia, or the hæmorrhagic diathesis, is meant a congenital and hereditary disease characterized by a tendency to persistent and uncontrollable bleeding from slight wounds, whether open or subcutaneous. This condition is often associated with extravasation of blood into the joints, and certain consecutive phenomena (Chapter XXII). The family history is always interesting, the disease being usually transmitted through the females to the males of a succeeding generation, whilst the former often escape entirely. The pathological cause of this affection has not yet been ascertained, no change in the vessels or constitution of the blood having been discovered. Unless hæmorrhage is actually occurring, nothing abnormal is noticed, but any injury is sure to be followed by excessive bleeding, spontaneous subcutaneous ecchymoses frequently occur, as also bleeding from the mucous membranes. Hence no operations must be undertaken on such patients unless absolutely urgent, even such a small matter as the extraction of a tooth having proved fatal.

The **Treatment** of hæmophilia should be directed more to correcting the constitutional defect than to pursuing the usual practice in dealing with hæmorrhage. The application or administration of hæmostatics, and substances which tend to promote coagulation and the formation of fibrin, should be resorted to. Calcium chloride, 1 drachm to  $\frac{1}{2}$  pint of water, given by enema, or 30 grs by the mouth, repeated several times a day, has been recommended, whilst fibrin ferment, suprarenal extract, and cocaine should be employed locally. Position and pressure are attended to, and in severe cases the actual cautery may prove useful, or the prolonged application of cold.

## CHAPTER XII

### INJURIES AND DISEASES OF ARTERIES — ANEURISM — LIGATURE OF ARTERIES

#### Injuries of Arteries

**Contusion** of an artery is the result of violence applied directly to the vessel wall. The effects vary with the severity of the injury and with the condition of the arterial tunics. If atheroma or calcification exists, thrombosis often follows slight injuries, and dry or senile gangrene may ensue, but in healthy arteries a good deal of violence is needed to produce such an effect, as their natural elasticity enables them to yield or slip aside, and thus the consequences are usually insignificant.

**Rupture or Laceration** may follow more severe blows or strains, weakness or disease of the arterial wall predisposing to it. It occasionally results from attempts to reduce old-standing dislocations, or to break down intra-articular adhesions when the vessel has become fixed in some abnormal position. If the rupture is **partial**, the inner and middle coats are usually torn through, and by projecting into the lumen of the vessel constitute a valve which prevents the passage of blood, and leads to subsequent thrombosis and occlusion. In cases where the lesion is limited to one side of the vessel, the clot may become organized over that spot, narrowing but not interfering with the lumen, and leaving an area of weakness from which an aneurism may subsequently develop. Again, when complicated with a septic wound, an ulcerative form of peri-arteritis may ensue, giving rise later on to secondary hæmorrhage. It is also stated that the adventitia is occasionally torn without injury to the tunica intima, and that an aneurism may result from a protrusion of the latter coat through the wound in the former, such an occurrence must be exceedingly rare. A dissecting aneurism (p. 306) may also result under special circumstances from such an accident.

**Complete Rupture** of an artery often leads to but little hæmorrhage in a severe lacerated wound, such as is produced when a limb is torn off: the inner and middle coats give way at a higher level than the adventitia, and curl up within it, whilst the outer coat and sheath contract over them, and thus prevent bleeding. If, however, the

artery is ruptured in a subcutaneous injury, such as a fracture or dislocation, extensive extravasation often ensues, constituting the condition badly termed a **Diffuse Traumatic Aneurism**. The objection to this name lies in the fact that there is no true sac wall as in an aneurism, the only boundary consisting of an ill-defined mass, partly coagulum, partly inflammatory exudation, and in part thickened and infiltrated tissues. A similar condition may ensue from a punctured wound dividing a vessel, where the track leading to it is valvular or becomes closed by clot or some external application.

**Symptoms** —The patient usually feels a snap, as though something had given way, accompanied by a sudden pain, localized to the part injured, and often shooting down the limb in the line of the vessel. These are succeeded by the following phenomena: (a) *Locally*, the formation of a diffuse, rapidly increasing swelling, the skin over which is at first normal, but soon becomes distended and bluish, and finally bright red and œdematous, when the tumour is threatening to give way. There is no increased local heat except in the later stages. Distinct pulsation is usually present, and some amount of thrill and bruit, synchronous with the heart's action, although these subsequently become less obvious. (b) *Distally*, diminished sensibility in the limb quickly follows, together with loss of pulsation in the vessels and a fall of temperature. It lies more or less useless and flaccid, and in colour is either white and blanched, or may be congested and œdematous if the extravasated blood presses upon the venous trunks. (c) *Generally*, the signs of hæmorrhage and shock manifest themselves in varying degree, according to the amount of blood lost and the character of the violence.

**Results** —(1) The swelling may increase steadily in size until the skin becomes so distended as to *rupture* or slough, and then, if help is not at hand, the patient dies of hæmorrhage. Occasionally the bleeding continues into an internal cavity, or into the tissues of a limb, to such an extent as to cause death without any external loss of blood. (2) *Suppuration*, accompanied by the general signs of fever, may result from auto-infection, or from the entrance of bacteria through the small valve-like wound. The whole swelling becomes red, hot, œdematous, and excessively tender, looking like a large abscess. Rupture and external hæmorrhage will probably conclude the case if surgical assistance cannot be obtained. (3) The pressure of the extravasated blood upon the veins or on the arteries needed for the collateral circulation may determine *gangrene* of the extremity, which is almost always of the moist type. (4) The process may become more or less *limited* after a time by coagulation occurring in the divided mouth of the vessel, which is thus occluded. Collateral circulation may be established, and thereby the health and vitality of the limb are maintained, whilst the blood-clot is absorbed or organized.

The **Treatment** is necessarily the same as for a divided artery communicating with an open wound, viz., to cut down and tie both ends. The circulation is first temporarily arrested by an elastic tourniquet, a free incision made, and all coagula removed. The bleeding-points

are then sought for and tied, the tourniquet being relaxed to allow them to become evident. If the distal end cannot be found, the wound is not closed, but should be stuffed with gauze, and allowed to granulate, a tourniquet being kept loosely about the limb ready to be tightened at any moment, if necessary. When suppuration is threatening, the same plan must be adopted, viz, free incision and tying the ends of the vessel if they can be found, but in cases where from the œdematous and unhealthy state of the surrounding parts this is impracticable, it will be necessary either to tie the main trunk on the cardiac side of the rupture, or to trust to pressure. If gangrene is imminent, or if secondary hæmorrhage occurs, amputation is the only resource.

**Penetrating Wounds** of arteries, if completely dividing the vessel, are always followed by hæmorrhage, although the blood may be unable to escape if the wound in the skin is small or valvular, or if the opening is closed by blood-clot or dressing, under these circumstances, the signs due to subcutaneous rupture of a vessel are produced. The amount of bleeding in open wounds varies according to the character, direction, and extent of the lesion, and with the size of the vessel. If a large artery is cleanly cut across, the bleeding is copious, whilst from a small vessel it soon ceases, owing to the contraction and retraction of the coats. When an artery is buttonholed—i.e., when a small segment of the wall is cut through—the hæmorrhage is often continuous and prolonged, since retraction cannot take place. The treatment of this condition consists in completing the division of the injured trunk, if it is a small one, thus allowing of contraction and retraction, or, if the vessel is of large size, in tying it above and below the opening, and dividing it between the ligatures.

If the wound is in the long axis of the vessel, it gapes but little, and the loss of blood is often slight, whilst if transverse or oblique, both contraction and retraction tend to increase the size of the opening, rendering it more nearly circular, and therefore the hæmorrhage in such cases is considerable.

If a small artery is divided close to its origin from a large main trunk, the blood escapes with a jet, the strength of which is proportionate to the blood-pressure in the main trunk, and not to the size of the vessel divided. In such a case the main trunk must be tied above and below the wound, and divided between the ligatures, and the distal end of the divided branch also secured.

A good many attempts have been made of late to effect the union of wounds in the walls of arteries without causing their obliteration, and with some success. Small longitudinal wounds may certainly be sutured, the stitches being of the finest silk and applied so that the edges of the tunica intima are brought accurately into apposition. Heidenhain reports a case where a wound 1.5 centimetres long in the axillary artery was successfully sutured in this way. End-to-end union of a divided artery has also been obtained in one or two cases,\* the upper end being invaginated into the lower, such a procedure

\* J. B. Murphy, *Medical Record*, January 16, 1897.

can, however, only be required under very exceptional circumstances

In punctured wounds of arteries the size of the penetrating body is all-important. A vessel may be traversed by a needle without hæmorrhage or any subsequent ill effect, but a larger puncture results in extravasation. If it ceases after a time, the blood-clot is absorbed, and the wound in the vessel closed by a cicatrix, which may subsequently yield to the blood-pressure, and give rise to a circumscribed aneurism. This occurrence is not unfrequent in the neighbourhood of the wrist from glass wounds, involving the radial or ulnar trunks, and hence is not uncommon among window cleaners or mineral-water bottlers.

**Arterio-Venous Wounds** are not so frequent in the present day as formerly, when venesection was in vogue. They follow penetrating wounds which involve an artery and vein lying in close contact, *e.g.*, at the bend of the elbow between the median basilic vein and the brachial artery, in the neck between the internal jugular and carotid,

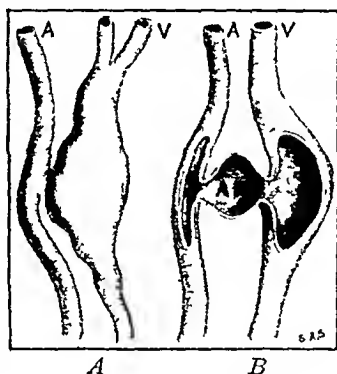


FIG 81.—DIAGRAMS OF *A*, ANEURISMAL VARIX AND *B*, VARICOSE ANEURISM  
A, Artery, V, vein AN, aneurism

in the groin between the femoral vessels, and occasionally in the orbit. They are also met with in military surgery, owing to the shape of the modern bullet and the limited amount of danger caused by it in the soft tissues. Two conditions may result.

An **Aneurismal Varix** is produced by a direct communication between an artery and a vein, no dilated passage intervening between the vessels (Fig 81, *A*). The venous walls, unfitted to withstand arterial pressure, are thereby dilated and rendered varicose. A pulsating venous tumour results, the dilatation extending for a variable distance above and below the opening, and at each beat of the heart a loud whizzing sound can be heard, likened by some authors to that caused by an imprisoned bluebottle buzzing in a thin paper bag. On palpation the thrill of the blood as it enters the vein can often be detected.

**Treatment**—Nothing is usually required beyond the application of

an elastic bandage or support to prevent further enlargement. Should pain or inconvenience arise, the artery should be secured above and below the abnormal communication with the vein. Occasionally the latter is so distended that it has to be removed before the artery can be reached. This operation should not be undertaken in the neck for the carotid-jugular varix unless absolutely essential. In the orbit electrolysis may be used with advantage.

A **Varicose Aneurism** differs from the above in that an aneurismal sac exists between the artery and the dilated vein (Fig 81, B). It is produced when the vessels are placed at a short distance from each other, or when extravasation of blood has separated them. The aneurism is of the false type, its walls being composed of newly formed cicatricial tissue, it is almost certain to become diffuse. The physical signs are similar to those of aneurismal varix, except that the aneurism can be sometimes detected by palpation, whilst a soft bruit may be heard over it, and the distension of the veins is not quite so marked.

**Surgical Treatment** is always required in these cases. Simple ligation of the artery above and below the abnormal communication will sometimes suffice, allowing the blood in the sac to coagulate, the veins will subsequently diminish in size, when the arterial blood-pressure is removed. Not unfrequently the vein overlaps the artery, and has to be tied and removed before the sac of the aneurism is reached, it is then better to excise the sac and tie the artery above and below. In the less urgent cases digital pressure to the artery above the sac is sometimes successful.

### Inflammation of Arteries

The various forms of inflammation of the arterial wall are usually named from the causes producing them—**Traumatic**, **Infective**, or **Embolic** arteritis. The terms *Endarteritis* and *Peri-arteritis* serve to distinguish inflammatory conditions which respectively start from the tunica intima, or reach the vessel from without, in both cases, however, the middle coat is generally involved, and the process may even finally spread beyond it, so that the whole thickness of the arterial wall is attacked.

1 **Traumatic or Plastic Arteritis** is the result of some injury, such as total or partial division of the vessel, laceration, bruising, etc. The phenomena are merely those of repair, resulting in occlusion of the vessel, viz, congestion of and exudation into the vessel walls from the vasa vasorum, together with proliferation of the tunica intima, they have been already described at p 276.

2 **Infective Arteritis** is a condition in which the arterial wall becomes invaded and softened by bacteria. It generally results from inflammation advancing inwards from the exterior (*peri arteritis*) in connection with septic wounds and spreading ulceration. The vasa vasorum are dilated, and an exudation of leucocytes occurs, as a result of the bacterial invasion, the peptonizing action of the toxins

thereby produced leads to softening of the vessel walls, the fibres of which lose their cohesion with each other. Finally, their resisting power may be so impaired that they yield before the blood-pressure and cause hæmorrhage, unless thrombosis has previously sealed the vessel. In the smaller arteries this is usually the case, but in those larger than the radial there is considerable danger of bleeding, especially if the irritation is confined to one side of the vessel. Secondary hæmorrhage from arteries tied in their continuity is generally due to this cause, as also bleeding from phthisical cavities, the vessels having previously lost the support of surrounding tissues, and being more or less dilated or aneurismal. Acute abscesses, septic ligatures, and malignant tumours may weaken an arterial wall and lead to hæmorrhage, whilst the infective agent sometimes reaches the walls from within, as from an infective embolus.

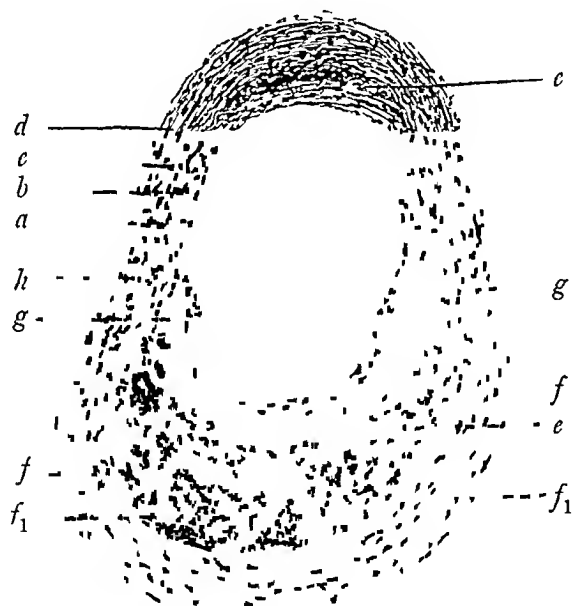


FIG 82 —SECTION OF ATHEROMATOUS CEREBRAL ARTERY  $\times 50$  (ZIEGLER)

*a* Intima considerably thickened *b* bounding elastic lamella of intima *c*, media *d* adventitia *e* necrosed denudeated tissue with masses of fatty detritus *f* and *f*<sub>1</sub>, detritus with cholesteroline tablets *g*, intima infiltrated with leucocytes *h*, infiltration of adventitia with leucocytes

**3 Embolic Arteritis**—When a vessel is blocked by a simple embolus, obliteration as a result of a simple plastic arteritis is the usual consequence. If the embolus contains some irritating or infective material, as in a case of infective endocarditis or pyæmia, an abscess may result, but if the irritant is less intense, the process may stop short of suppuration, and yet an aneurismal dilatation of the softened wall takes place. The latter process is the most common cause of *spontaneous* aneurism in children.

**4 Acute Endarteritis** is met with rather as a pathological curiosity

than as a condition of any clinical import. It is usually associated with acute endocarditis, however produced, or may accompany some of the chronic forms described below. It is evidenced by the presence on the inner aspect of the vessel of more or less raised patches, somewhat pinkish and gelatinous in appearance, soft and elastic in consistency, and although the polish is lost, the endothelium is usually intact. It is found in the aorta, or in smaller vessels, especially near inflamed wounds.

5 **Chronic Endarteritis** is an exceedingly common affection, and the following forms may be described.

(a) **Simple Chronic Endarteritis**, resulting in **Atheroma** (Gr *ἀθήρη*, 'gruel' or 'pap'). This condition is constantly found in elderly people, but especially in drinkers and those who have suffered from chronic Bright's disease, gout, or syphilis, it arises from continual strain and increased blood-pressure, and hence often starts in the convexity of the aortic arch, at the spot where the impact of the blood-stream is most felt as it is ejected from the ventricle, or in places where a vessel passes over or around some bony projection, or at the bifurcation of a main artery, or where a large branch is given off, thus causing a sudden decrease in its lumen. It is rarely found in the smaller arteries, except those of the heart or brain.

The *pathological* phenomena consist at first of a proliferation of the deeper parts of the tunica intima, giving rise to opaque, milky-looking, non-vascular patches (Fig 82, *g*), which may organize into fibroid tissue, or undergo fatty degeneration (*e* and *f*). They are arranged longitudinally or around the mouths of large branches. The tunica media is more or less involved in the process, and the adventitia is often thickened externally. As soon as the fatty changes have commenced, the patches become yellowish in colour, somewhat elevated from the inner surface, and irregular in outline, they are small at first, but increase in size, and coalesce one with another. The contents are now fluid or cheesy in consistency, constituting the so-called 'atheromatous abscess,' although no true pus exists, the pultaceous material consisting of fatty granules and débris, with oil globules and plates of cholesterine (Fig 82, *f*<sub>1</sub>). It may be absorbed entirely, leaving a weakened spot in the wall of the vessel, from which an aneurism may arise, or the tunica intima may give way over it, allowing the contents to be swept into the general circulation, where it probably does no harm, and the raw surface left behind is known as an 'atheromatous ulcer.' The outer coat has by this time become thickened, and hence no immediate ill result follows the breach in the inner coats, although subsequently dilatation may take place, even though cicatrization of the ulcer has occurred. Again, the blood may find its way through the opening into the substance of the wall and strip up the inner from the outer layers, constituting a 'dissecting aneurism', or a localized thrombus may form, causing occlusion of the vessel.

Not uncommonly the cheesy contents of the abscess become inspissated, and later on infiltrated with lime salts, resulting in the



formation of calcareous plates, which are either covered with endothelium, or exposed to the blood-stream, and hence may cause thrombosis, or become detached as an embolus, or the blood may get in under the plate and form a dissecting aneurism

A condition of endarteritis evidenced by proliferation of the tunica intima is always met with in chronically inflamed tissues, as also in diabetes, such does not, however, run on to atheroma

(b) **Chronic Syphilitic Endarteritis** is chiefly met with in the tertiary stage and is characterized by an overgrowth of the tunica intima (Fig 83, *a*), which is subsequently associated with infiltration of the media (*c*), and much more so of the adventitia (*d*) The change occurs in small arteries, especially those of the brain or kidneys, or

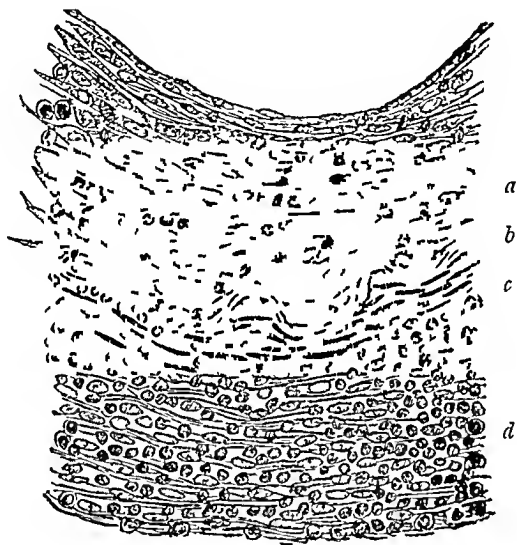


FIG 83 — SYPHILITIC ARTERITIS  $\times 150$  (ZIEGLER)

*a* Intima greatly thickened by newly-formed fibro cellular tissue *b* fenestrated elastic lamina of Henle *c*, muscle fibres of media, infiltrated towards the left *d*, adventitia thickened by cell infiltration and hyperplasia

in the neighbourhood of gummata, and but rarely in the larger vessels, although a considerable percentage of individuals affected with internal aneurism have suffered from syphilis It differs from simple atheroma (1) in attacking small arteries, (2) in affecting the whole circumference of the vessel, and not merely patches, (3) the newly-formed tissue becomes vascular, and does not undergo fatty degeneration, and (4) it leads to narrowing or occlusion of the vessel rather than to weakening and dilatation When involving the cerebral arteries, various forms of monoplegia, or even hemiplegia, may result

(c) It is still more or less an open question whether the so-called **Endarteritis obliterans** or **proliferans** is truly syphilitic or not In some cases a syphilitic history has been present, but in other marked

instances it has been entirely absent. The main arteries are gradually obliterated in persons apparently sound in health, as a result of which the peripheral parts become anæmic, diminished in vitality, or even gangrenous. The tunica intima is converted into a thickened and vascular mass, which narrows and finally occludes the lumen. This disease, which is by no means common, is associated with considerable local pain.

(d) **Chronic Tuberculous Endarteritis** is met with as a proliferation of the tunica intima, with or without thickening of the adventitia, in all places in which tubercle is actively developing, in fact, tubercles are often formed around arterioles, and as the mass grows the vessel is slowly occluded and replaced by the typical anatomical structure of the milary tubercle. The tuberculous endarteritis may, however, spread widely beyond the focus of the mischief, and in almost any portion of pulpy granulation tissue this change can be seen.

### Degeneration of Arteries

**Fatty Degeneration** occurs independently of atheroma, involving merely the tunica intima, and manifesting itself in small patches, yellowish in colour and stellate in shape. As a rule, it is of but little significance, but occasionally the infiltration is deeper, and the tunica intima gives way, causing the so-called *fatty erosion*, and then an aneurism, possibly of the dissecting type, may arise. The most usual seat of this trouble is the aorta.

**Primary Calcareous Degeneration** (Fig 84) is chiefly met with in the smaller arteries of the extremities. It occurs in elderly people at the same time of life as the calcification of cartilages, etc., and commences by the deposit of lime salts in the muscular fibres of the tunica media, constituting a series of calcareous rings which transform the elastic expansile vessels into rigid tubes like gas-pipes, through which can alone pass a fixed and unchangeable minimal supply of blood. It is often associated with true atheroma of the larger vessels.

The affected limb passes into a condition of chronic anæmia and impaired nutrition, resulting in coldness of the feet or hands, cramps and spasms of muscles, sensations of pins and needles, etc. The endothelium is not removed except in the later stages, and then thrombosis may be produced, or a similar result may arise from the lodgment of an embolus. Senile gangrene is a common termination of such arterial changes. From the general rigidity of the vessel, and the method of deposit of the lime salts, it follows that aneurism is not likely to occur.

**Amyloid Degeneration** of the viscera commences in the arterial walls, but is described elsewhere (p 70).

**The Effects of Arterial Inflammation and Degeneration** are both local and peripheral. *Locally*, **Thrombosis** may be produced whenever the lining endothelium is removed and a raw surface exposed, upon which fibrin can collect. Under this fibrinous coating repair is often effected without further complication, but if the blood-stream is

retarded, or the lumen of the tube narrowed, complete thrombosis may follow, the clot extending some distance up or down the vessel, or even from a branch into the main trunk, which may be blocked by this means. **Aneurism** is also a result of any weakening of the arterial tunics. **Obliteration** of the artery is caused, either by thrombosis, or by excessive proliferation of the tunica intima (as in syphilitic or tuberculous disease), or by gradually increasing pressure from without. Lastly, **Spontaneous Rupture** is occasionally produced.

*Peripherally*, defective blood-supply and consequent **lowered vitality** are the most marked results of arterial disease, leading to various forms of ulceration and gangrene. Thus, senile gangrene is due to

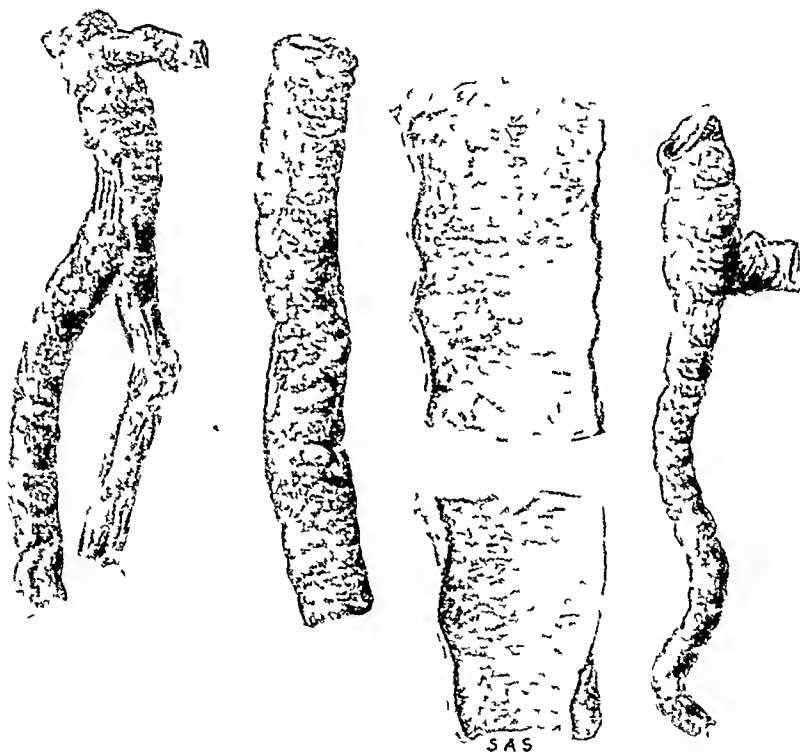


FIG. 84.—PRIMARY CALCAREOUS DEGENERATION OF ARTERIES (FROM COLLEGE OF SURGEONS' MUSEUM)

calcareous changes in the arteries, fatty degeneration of the heart follows atheroma of the coronary arteries, whilst softening of the brain may ensue from various affections of the cerebral vessels. Similar results may also arise from **emboli** detached from areas of local disease.

### Aneurism

An **Aneurism** is a tumour filled with blood communicating with the interior of an artery, and due to dilatation of part or the whole of the vessel walls.

**Causes**—Aneurisms may be divided into the pathological and the traumatic, the distinction between them being that in the former the coats of the artery are primarily diseased, whereas in the latter they may be previously healthy. However, it must not be forgotten that persons with diseased arteries are just as liable to injury as, and even more so than, those with healthy vessels, and thus no strict line of separation can be drawn between the two forms. The causes of aneurism may be conveniently grouped under two headings

1 **Changes in the Vessel Walls**, by which their resistance to the intravascular pressure is diminished. Many varieties of *disease*, e.g., atheroma, predispose to aneurismal dilatation, especially if occurring in *sypilitic or gouty* men about middle life, in whom, although the arterial tunics may be weakened, the power of the heart and the resulting blood-pressure are by no means diminished. Calcification, on the other hand, is antagonistic to aneurismal dilatation. Any *injury*, a contusion, a penetrating wound, or a strain, may so interfere with the integrity of the vascular coats as to result in aneurism, and, indeed, a cicatrix in an arterial wall must always be looked on as a weak spot predisposing to dilatation. The lodgment of an *embolus* in the smaller arteries is stated to be one of the most common causes of spontaneous aneurism in young people.

2 **Increase in the Blood-Pressure** is another factor, especially when due to heavy *strain* or *exertion*, which leads to irregular excitement and increased action of the heart. Steady laborious employment, such as is seen amongst artisans and mechanics, or regular exercise, does not appear to predispose to this condition, but irregular intermittent efforts, in which for the time being every power is strained to its utmost, are very liable to determine its occurrence. A day's exertion in the hunting or shooting field by an elderly man, accustomed to sedentary occupations, is often the cause of some vascular lesion, such as aneurism, apoplexy, etc. Hence aneurisms are more frequently seen amongst men than in women, in the proportion of seven to one, whilst they are much more common among the dwellers in Northern climates than in the more lethargic and ease-loving inhabitants of the South. The energy and activity of the Anglo-Saxon race especially predispose them to this disease.

**Structure of an Aneurism**—Formerly much stress was placed on the terms *true* and *false*, the word 'true' meaning that all the coats of the vessel were present, whilst the 'false' were those in which the sac wall comprised little or none of the original arterial tunics. This distinction is of comparatively little value, since no aneurism which has attained to any size is in reality true. The *sac* consists more or less evidently of a distension of all or part of the original walls of the vessel whilst it is small, but as the aneurism increases, the original structure is replaced by a mass of newly-formed fibrous tissue, due to a condensation and matting together of the surrounding structures, with or without an internal lining of laminated fibrin deposited on parts where the endothelium has disappeared. The *contents* of the sac depend on the character, age and size of the

aneurism Whilst still small and with a complete endothelial lining, it contains fluid blood, but as the tumour grows, and especially if of the sacculated type, fibrin is deposited in layers which gradually encroach on the cavity and may in time completely fill it, so that in rare cases a spontaneous cure results. The oldest laminæ are dry and yellowish-white in colour (the so-called *active clot* of Broca), those more recently deposited are softer and more reddish, whilst the last formed is merely like ordinary blood coagulum (the *passive clot* of Broca). No single lamina covers the whole area, but layer is arranged over layer (Fig 85) in such a manner that the oldest and necessarily the smallest laminæ are nearest to the sac wall.



FIG 85 —SACCULATED ANEURISM (MUSEUM OF ROYAL COLLEGE OF SURGEONS)

The small mouth of the saccule is clearly seen, and the cavity is nearly filled with laminated clot

Three chief forms of aneurism have been described the fusiform, sacculated, and dissecting

The Fusiform Aneurism (Fig 86, A) is one in which the whole lumen of the vessel is more or less equally expanded, so that the swelling is tubular in character. It is due rather to a general increase of blood-pressure, or to a widely extended disease of the arterial walls, than to any localized lesion or injury, and hence is more commonly met with in the larger internal vessels than in those of the extremities. The tunica intima is usually represented throughout the whole extent of the sac, but is thickened and atheromatous in patches, the margins

and surfaces of calcareous plates being indicated by flocculi of fibrin, which are attached to them, although no regular laminated deposit may be present. The tunica media is stretched, atrophied, and in the later stages practically non-existent, whilst the adventitia is much thickened by inflammatory new formation and by incorporation with the surrounding tissues. The progress of fusiform aneurisms is generally slow, so that in some situations, *e.g.*, the thorax, they may attain enormous dimensions, and cause grave symptoms by their pressure. A natural cure is almost impossible, and hence, if unchecked by treatment, a fatal termination is caused by rupture or by implication of important neighbouring structures. Frequently one portion of the aneurismal wall yields more than another, and thus a localized sacculation is superadded, which by its rapid increase in size may destroy life.

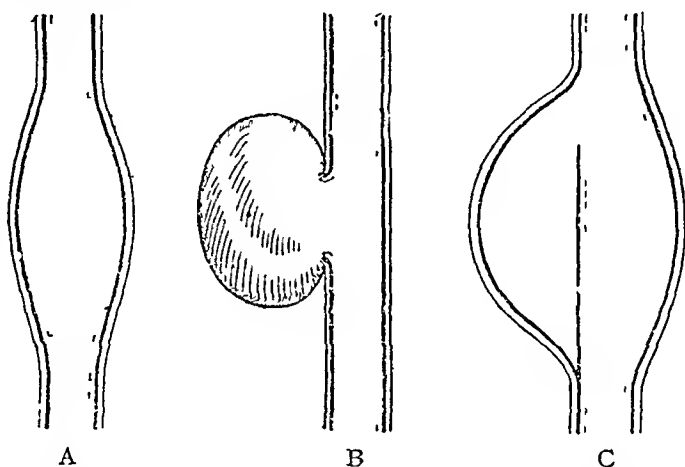


FIG 86 — DIAGRAMS OF FUSIFORM SACCULATED, AND DISSECTING ANEURISMS

In the first the walls are expanded but more or less normal in texture. In the sacculated, the normal structure of the arterial wall ceases abruptly at the commencement of the saccule. In the dissecting, the arterial wall is split into two lamellæ.

The interrupted fine line is supposed to represent the intima, the continuous dark line, the media, and the continuous fine line the adventitia.

2 A Sacculated Aneurism (Figs 85 and 86, B) is due to the yielding of some weak patch in the vessel wall which does not involve the whole circumference, or, as just mentioned, it may spring from a fusiform aneurism. It communicates with the interior of the artery by an opening of variable size. All traumatic aneurisms, whether due to the yielding of a cicatrix, or to the partial division of the coats of the vessel, are of this type, which is hence found most commonly in the extremities. The inner and middle coats can usually be traced as far as the mouth of the saccule, but there they are suddenly lost, the wall being constituted by a mass of fibro-cicatricial tissue, upon which laminated fibrin readily forms, thus increasing its thickness and power of resistance. Their progress is, however, much more

rapid than that of the fusiform, generally ending in rupture or diffusion, although occasionally a natural cure results. The blood as it enters the sac impinges against the wall furthest removed from the heart, and thence eddies back in circles, coagulation being thereby favoured.

3 A **Dissecting Aneurism** (Fig 86, C) is one in which the blood forms a cavity within the wall of the vessel by stripping up the inner from the outer half, the line of cleavage being within the middle coat, half going with the adventitia, half with the intima. It is usually the result of extensively diffused atheroma. The blood thus driven into a cul-de-sac may remain limited to this cavity for some time, or it may find its way outwards and become diffused, or burst back through another atheromatous spot into the interior of the vessel. The condition occurs chiefly in the thoracic aorta, but cannot be recognised *ante-mortem*.

**Symptoms and Signs of a Circumscribed Aneurism** — These may be divided into two groups: the intrinsic and extrinsic.

**Intrinsic Signs** — A tumour, pulsating synchronously with the heart's beat, is present in the course of a vessel. The pulsations are distensible or expansile in character, *i.e.*, the whole tumour increases in size at each systole, and that evenly in all directions, so that if the tumour is lightly grasped in any position the fingers are separated. A definite thrill can often be felt as the blood enters the sac at each heart-beat. If the supplying vessel is compressed on the proximal side, the pulsation ceases, and the tumour diminishes in size and becomes softer, this is more marked in fusiform than in sacculated aneurisms. The application of pressure to the sac itself, whilst the afferent trunk is compressed above, may still further diminish its size. On removing the pressure, the swelling regains its old dimensions in a certain definite number of beats, usually not more than two or three. Pressure on the distal side of the sac makes it more tense and the pulsation more marked, unless such compression is very prolonged. On auscultating the tumour, a bruit of variable character may be heard, usually it is loud, harsh, and systolic, but sometimes quiet and musical. It is occasionally double in some forms of sacculated aneurism, and in the aorta when regurgitation through the aortic valves is also present. The bruit is loudest and most rasping in the fusiform variety, and may be absent in the sacculated form, when the mouth is small and the cavity nearly full of clot. Great distension of the sac is unfavourable to the production of a bruit.

The **Extrinsic Signs** of aneurism are those occurring in neighbouring or distal structures from its constantly increasing size and pressure, and the interference produced by it with the circulation. The pulse on the distal side is diminished and delayed, its diminution being caused partly by the obstruction experienced, but also in some cases by the pressure of the sac upon the trunk above or below the tumour. The delay is due to the interference with the transmission of the heart's impulse by the intervention of the aneurismal sac. The dicrotic notch is usually absent. The smaller vessels engaged

in establishing collateral circulation may be compressed, and thus the vitality of the limb considerably impaired. Pressure on the accompanying vein or *veins* results in diminution of their calibre, and possibly a localized thrombosis, together with distal congestion and œdema. Compression of *nerves* occasions neuralgia, spasm, or paralysis. *Muscles* are displaced, expanded, and attenuated, *bones* may be eroded, as evidenced by a deep, constant, boring pain, and even spontaneous fracture may ensue, whilst *joints* are encroached upon and disorganized. *Tubes*, such as the trachea or œsophagus, are often injuriously constricted and laid open by ulceration. It is an interesting fact to note that resisting tissues, like bone, are much more liable to be eroded than elastic, yielding structures, such as cartilage, and in cases where the vertebral column is encroached upon by an abdominal or thoracic aneurism, the bones always manifest greater destructive changes than the intervertebral discs.

The increased difficulty in propelling the blood through the sac usually induces a certain amount of compensatory hypertrophy of the *heart*. Fibrinous masses are occasionally set free as *emboli*, and lead either to a spontaneous cure, or to gangrene of the parts supplied by the vessel, or to death if the brain is involved. *Gangrene* may also be induced as a result of the diminished blood-supply to peripheral parts, especially if associated with interference with the venous return. It is usually of the dry type, involving merely one or two fingers or toes, but when attacking more fleshy parts, or if venous congestion is marked, it is moist in character.

The Differential Diagnosis of a circumscribed aneurism is usually not difficult, but the following conditions may simulate it somewhat closely. 1. A *tumour* or *chronic abscess* situated near an artery, and deriving *transmitted pulsation* from it, is recognised by the impulse being merely heaving-in-character, and not expansile, by the pulsation ceasing entirely if the tumour is lifted from the vessel, or allowed to fall away from it by assuming a suitable position, by the size of the tumour not diminishing if the pulsation is stopped by pressure on the vessel above, and by the fact that after stoppage of the pulsation the first beat is equal to the subsequent ones, whereas in an aneurism it almost always requires more than one beat to re-establish the strength and force of the impulse. Moreover, the pulse below is not affected in the same way or to the same extent as when an aneurism is present. 2. An *artery* is sometimes *pushed forwards* by an underlying growth, and its pulsation in a more than usually superficial position may suggest an aneurism. The distinguishing features are the limitation of the pulsation to the line of the vessel, and the absence of pulsation in the underlying growth. 3. A *pulsating sarcoma* or *nævus* is known by being rarely limited exactly to the line of the artery, pulsation being present in situations where an aneurismal dilatation could not be felt, and being less forcible and regular in its character. The consistency of the swelling is more variable, and pressure over the afferent trunk does not diminish its size to any marked extent. Moreover, a sarcoma is usually more adherent to



the deeper structures, and its limits are not so accurately defined  
 4 The pain caused by an aneurism may lead it to be mistaken for *rheumatism or neuralgia* (e g , for sciatica in popliteal aneurism), and in every case of obstinate pain of this kind the arteries should always be carefully examined

**Natural Terminations and Results**—1 **Spontaneous Cure**, though very unusual, may occur in sacculated aneurisms (a) It may be due to the *gradual* deposit within the sac of fibrin, which, in the first place, limits the expansion and extension of the aneurism, but may finally increase to such an extent as to occupy the whole cavity This condition can only obtain in saccules with small mouths, and in vessels of the second magnitude, hardly ever in the aorta or larger trunks, the impetus of the blood-stream being too great to permit of the necessary deposit of fibrin (b) It may arise as the result of the *sudden* coagulation of all the blood in the sac from the stoppage of the circulation, owing to the lodgment of an embolus either at the mouth of the aneurism or in the trunk immediately below (c) The aneurism may become so large as to compress the main vessel, either going to or coming from it, thus bringing about its own cure (d) Again, if the sac becomes inflamed, consolidation may occur with or without suppuration, although the latter process, as will be seen anon, is attended with serious danger to life and limb

In the non-inflammatory conditions the sac becomes more and more firm, the pulsation less forcible and distinct, the bruit diminishes, and finally consolidation is effected, a firm fibroid tumour alone remaining, which gradually shrinks, whilst the collateral circulation is opened up so as to supply the limb below It is sometimes by no means easy to recognise the fibroid mass resulting from the spontaneous consolidation of an aneurism, and in making a diagnosis the history has mainly to be depended on The existence of a tumour in the line of an artery, the probable occlusion of the main trunk, and the fact that the circulation is carried on by means of collateral branches, are the chief points which can be ascertained by a physical examination

2 ~~Diffusion and Rupture~~ result from yielding of the walls of an aneurism, as an outcome of some mechanical injury or from simple over-distension

When an **internal** aneurism gives way, the patient usually experiences a sensation of pain in the part, and becomes pale, cold, and faint, possibly dying within a few minutes or, at most, hours, or there may be a sudden gush of blood from the mouth if the trachea or œsophagus has been opened Sometimes internal aneurisms leak slowly, and the final stage lasts some days

When an **external** aneurism yields, it may do so slowly or quickly If the blood becomes effused *slowly* (constituting what is sometimes called a *leaking aneurism*), the tumour gradually increases in size, and its outline is less clearly limited, the pulsation diminishes in force and distinctness, and the signs of pressure upon the veins or nerves become more urgent, until gangrene sometimes supervenes If the

aneurism ruptures *suddenly*, the patient experiences severe pain in the part, which becomes tense, swollen, and brawny, all pulsation ceases, both in the aneurism and below it, and gangrene of the limb follows, or even death from syncope, arising from the amount of blood extravasated, either externally if the skin gives way, or into the tissues and under the fasciæ. Suppuration may also occur in these cases, the skin becoming red and inflamed, and finally external rupture may follow. In the absence of history the recognition of diffuse aneurisms is by no means simple, especially when they become inflamed, and then only the most careful attention to the facts to be made out by digital examination can determine the nature of the case.

3. Suppuration is an exceedingly serious, but by no means a usual, complication. It may arise in the following ways (a) After ligation of the main vessel, especially when the wound becomes septic, and there is a good deal of loose cellular tissue around the sac, as in the axilla, (b) after diffusion, partial or complete, of an aneurism, where there is great tension upon surrounding parts. Auto-infection or the presence of an infective embolus may finally determine the suppurative process. The tumour shows signs of inflammation, becoming hot, red, painful, and swollen, and the skin over it may pit on pressure, whilst fever and general constitutional disturbance are also present. Sooner or later, if left to itself, the tumour points at one spot and bursts, giving exit to a mixture of blood-clot, pus, and a greater or less amount of bright red blood. The patient either dies at once from syncope, or a little later from secondary hæmorrhage and septic poisoning, unless efficient treatment is adopted. Occasionally, but very rarely, the afferent trunk becomes plugged by a thrombus, and spontaneous cure may thereby be induced.

### Treatment of Aneurisms

I General Treatment is employed as an accessory to surgical measures, or must be depended on entirely in cases where local means are impracticable or contra-indicated, such as in internal aneurisms, it is then to be looked on rather as palliative in nature than curative. The general condition of the patient must be carefully investigated, since aneurisms are associated either with plethora or with an enfeebled and cachectic state of the system.

In plethoric individuals, where the disease often runs a rapid course, absolute rest, both mental and physical, must be enjoined, with the removal of all sources of irritation and worry. The bowels are freely opened by a calomel purge at the commencement of treatment, and watery stools should be subsequently induced by 20-grain doses of pulv. jalapæ co. two or three times a week, so as to increase the plasticity of the blood. The heart's impulse may be diminished by the use of aconite, or even by venesection when it is very forcible. Iodide of potassium is useful both for reducing blood-pressure and in cases where a syphilitic history is

present The diet must be diminished, all stimulating articles being eliminated, and only highly-nutritious material allowed, and that mainly of the nitrogenous type, with as little fluid as possible Various special methods, *e.g.*, Tufnell's, Valsalva's, etc., have been recommended, but it usually suffices to limit the dietary as much as is in conformity with the patient's comfort and well being, and not to allow more than about a pint of fluid in the day

In *weakly individuals*, whilst enjoining strictly a recumbent posture, the surgeon should prescribe iron and a somewhat more liberal diet, in order to improve the quality of the blood

**II Surgical Treatment**—Whichever of the plans described below is selected in any particular case, the general health must be carefully attended to, and the condition of internal organs fully investigated beforehand, as great harm may follow injudicious interference, if internal aneurisms co-exist

**A** The ideal treatment consists in so dealing with the arterial wall as to obliterate the aneurism, but without occluding the original lumen of the vessel This is possible in a few selected cases of sacculated aneurism, and a method of *Arteriorrhaphy* has been suggested and practised by Matas \* of New Orleans for this purpose, in which the aneurismal wall is sutured up into pleats Further experience is required before any definite opinion can be given as to its practicability or value

**B Complete Extirpation** of the aneurismal sac may be looked on as the best and most satisfactory method of treatment in the majority of cases The sac is thus dealt with as if it were a tumour, although, owing to the adhesions always present, complete separation of the wall from surrounding parts is often difficult The limb is exsanguinated by elevation, and in suitable cases the aneurism is removed without opening it, and the vessel secured by ligature above and below, as also any branches which may arise from it When, however, a large saccule obscures the main trunk, it may be necessary to open it and turn out its contents before attempting its extirpation Not unfrequently the vein will be encroached on in this dissection, and it may have to be removed, bad results are not likely to follow, since probably its lumen has been already diminished by the pressure of the sac, and an efficient collateral venous circulation established This method has hitherto been chiefly applied to small aneurisms of the peripheral vessels, and, indeed, in the majority of such cases no other plan need be considered, surgeons are now, however, extending its scope to the larger trunks, such as the popliteal, carotid, external iliac, and subclavian, from each of which aneurisms have been successfully extirpated, whilst as far back as 1883 one of us removed in this way a recurrent femoral aneurism, involving the vein, with a good result † It is also attempted as an alternative to amputation for recurrent, diffused, and suppurating aneurisms The results of this operation which have been recently recorded are most encouraging

\* *Annals of Surgery*, February, 1903

† *Lancet* 1883, ii p 1082

primary union of the wound is often obtained, and hence the length of treatment is curtailed, whilst all chances of recurrence are removed. Statistics also show that there is less danger of gangrene, and this depends, as Pearce Gould has pointed out, on the fact that only one set of collateral circulation is called upon, viz, that required to bridge the gap made by removing the aneurism, whereas in the Hunterian operation a double set is needed, viz, at the site of the ligature, and round the consolidated aneurism. It is obvious that the nutrition of the limb is best secured when what Gould calls the 'irreducible minimum' of operative treatment, viz, the occlusion of the vessel only at the site of the aneurism, is undertaken. Secondary hæmorrhage is also less likely to occur.

C The *deposit within the sac of fibrin*, which shall subsequently organize and thus lead to the obliteration of both sac and supplying vessel, was the ideal aimed at by the earlier surgeons, and has still to be relied on in many cases. It is obvious that a slow and gradual deposit of laminated fibrin is likely to be more satisfactory than the sudden distension of the sac with soft red clot.

The various plans adopted with this end in view are as follows

1 **Compression** of the main vessels, usually on the proximal side of the aneurism, was much vaunted by the Dublin school of surgeons in the last century, and gave not a few good results. It may be applied either continuously or at intervals. If *intermittent*, the main vessel leading to the aneurism is controlled by means of fingers (digital compression), or by mechanical contrivances (such as a tourniquet or a conical bag filled with shot), for as long a period as the patient can bear, which usually does not exceed thirty minutes, especially if there is any nerve in the immediate neighbourhood. There seems to be no necessity to completely arrest the flow of blood through the sac, so long as the blood-pressure is sufficiently diminished to permit of coagulation within it. *Continuous* pressure can, as a rule, only be maintained under an anæsthetic, and in such cases the circulation through the sac is entirely stopped, so as to allow not only of its contraction, but also in some instances of the rapid coagulation of its contents. Such pressure may be effected by the fingers of relays of dressers, taking shifts of ten to fifteen minutes at a time, but inasmuch as its effective maintenance is excessively tiring and difficult, arrangements should be made whereby some weight, such as a conical shot-bag, rests upon the thumb or finger employed, thereby relieving muscular strain. Tourniquets may be similarly utilized, but are less satisfactory, since they require more skilful and accurate adaptation, and are liable not only to slip out of place, but also to bruise the coats of the vessels.

Although in suitable cases compression certainly has been successful, and may be given a trial before ligature, yet it is unwise to persevere with it for too long if signs of improvement are not quickly observed, lest the collateral circulation be increased to an undesirable extent, and the success of the subsequent operation jeopardized. Especially is this the case in plethoric individuals with high arterial tension. On

the other hand, in feeble, weakly patients, where gangrene of the limb might be anticipated, the opening up of the collateral circulation by compression, even if the aneurism is not thereby cured, is by no means a disadvantage

Necessarily, the part of the skin to which pressure is applied must be carefully protected from local irritation by shaving and removal of hairs, by the use of dry aseptic dusting-powders, and by the surface of any pad employed being perfectly smooth, and the skin not wrinkled beneath it

2 **Ligature** of the main vessels leading to or coming from the aneurismal sac must next be considered. The oldest procedure, the **Operation of Antyllus**, consisted in laying open the sac, turning out the clots, securing the vessel above and below, and allowing the wound to heal by granulation (Fig 87, A). Performed, as it was originally, without anæsthetics or antiseptics, it was naturally attended with great mortality, since, even if secondary hæmorrhage did not occur from the main trunk, it was liable to follow from any of the branches which arose from the dilated portion of the vessel

In **Anel's Method** (Fig 87, B) the artery was tied just above the sac on the cardiac side, with no branch intervening, this also proved dangerous, since secondary hæmorrhage frequently resulted, either from suppuration within the sac, or from injury to the sac during the operation, or from yielding of the arterial wall at the site of ligature from septic peri-arteritis

3 **Hunter's Operation** (Fig 87, C), which consists of ligature of the main vessel on the cardiac side at some distance from the aneurism, was first performed by him in 1785. The object to be attained is not to cut off absolutely the blood-supply to the sac, but to allow the blood to enter it with a greatly diminished impulse, and in small amount at first, thus permitting of the contraction of the sac wall and of the gradual deposit of fibrinous clot within it. The sac thus becomes consolidated, and finally transformed into a mass of firm fibroid tissue. The operation is most likely to succeed in cases where the aneurism is well defined and not large enough to exercise injurious pressure on surrounding parts, whilst it is desirable, though not essential, that no branch of large size should intervene between the point of ligature and the sac. The operation is *contra-indicated* (1) in cases where serious cardiac disease co-exists, or when an internal aneurism is also present, rendering undesirable any sudden increase of the blood-pressure, as by occlusion of a main vessel, (2) where pressure over the vessel does not control the circulation through the sac, (3) where the peripheral vessels are extensively calcified, (4) where gangrene of the limb is threatening or present, or (5) where bones or joints have been seriously involved

**Distal Ligature** is only practised for aneurisms situated in positions where it is impracticable to deal with the artery on the cardiac side of the sac, such as the innominate, lower part of the carotid, or first part of the subclavian. **Brasdor's Operation** consists in tying the main trunk beyond the sac, so as totally to cut off the circulation

through it (Fig 87, D) In Wardrop's Operation a ligature is placed on one or more of the distal branches (Fig 87, E) In the former the sac gradually contracts, and thus allows of the deposit of fibrin, in the latter proceeding, where the circulation is only partially controlled, the diminution of the size of the aneurism goes on much more slowly, and the chances of the deposition of clot in the sac are correspondingly lessened

It is not unusual, after the application of a ligature to a main artery for aneurism, to observe a **return of pulsation in the sac** after a few days In the majority of cases this only continues for a short time, and is by no means an unfavourable sign, indicating the re-establishment of the collateral circulation, but if it commences a week or ten days after the operation, it is more likely to persist It is most frequently seen in cases where the main vessel has been tied at some

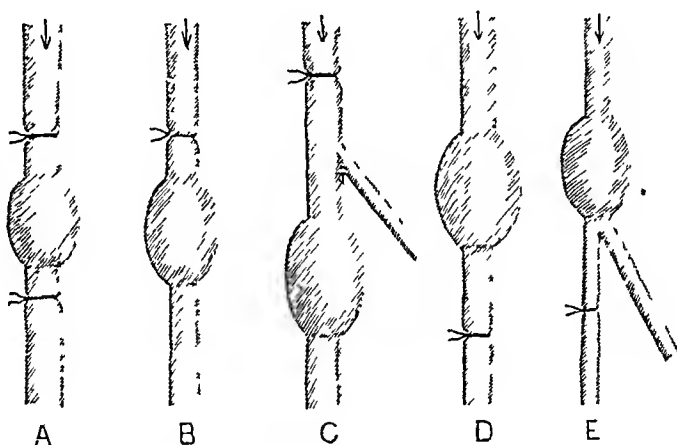


FIG 87 —METHODS OF APPLYING LIGATURES FOR ANEURISMS.

A, Method of Antyllus B, Anel's operation C the Hunterian operation, D, Brasdor's operation, E, Wardrop's method

distance from the sac, as in the superficial femoral for popliteal aneurism, and where one or more large and important collateral branches carry blood into the artery below the ligature or directly into the sac The early recurrence of pulsation needs no *treatment* in most instances, since it disappears spontaneously, but when it comes on at a later stage, it demands serious attention Rest, elevation of the limb, and judicious pressure over the trunk above the site of ligature, should first be tried These failing, the following courses are open (a) The artery may be again tied, either nearer the sac when feasible, or further away from it, (b) where the aneurism can be reached, it may be cut down on and dissected out, the best course to adopt if it be practicable, or (c) amputation just above the aneurism may be called for as a last resource, when the tumour is rapidly increasing or threatening to become diffuse, or if gangrene is impending

3 **Electrolysis** has been occasionally employed in dealing with

thoracic aneurisms when a saccule has developed in an accessible position. The clot, however, is soft and liable to break up, and the results have not been very satisfactory. For details of the methods of employing electrolysis, see p 353.

4 **The Introduction of Foreign Bodies into the Sac** (*Moore's Method*) has not been followed by much success, although a few cases of abdominal aneurism seem to have derived temporary benefit from it. Steel wire has been usually employed, it is firmly wound round a cotton reel to give it a spiral coil, and inserted into the sac through a very fine cannula. Varying lengths from 10 feet to 26 yards have been introduced.

5 The combination of the last two methods (as originally suggested and practised by an Italian, Corradi, in 1879) has been attended by some very happy results, especially in the hands of Stewart of Philadelphia. He introduces a variable length of gold or silver wire (No 30 gauge), preferably the former, through a small cannula, and then performs electrolysis through the wire which is attached to the positive electrode, whilst the negative electrode is placed on the back. The current is gradually increased up to 60 or 80 milliampères, and the whole proceeding lasts about thirty minutes. Finally, the wire is cut short and pushed into the sac. Several most brilliant results have followed this plan of treatment, including the cure of an innominate aneurism, the patient living for three and a half years, and of an aneurism of the abdominal aorta, dealt with by transperitoneal operation. We ourselves have treated a subclavian aneurism in this way with considerable temporary benefit.

An ingenious contrivance has been designed by Messrs D'Arcy Power and Colt for this purpose. It consists of a fine wire wisp or cage, which can be introduced closed up as a cartridge into a special trocar, and pushed by a ramrod into the sac, where it expands of itself umbrella-fashion, thereby exposing a large surface of wire on which coagulation can occur, it is also arranged for electrolysis. Satisfactory results have attended its employment.

D Quite distinct in principle from the preceding plans is that associated with the name of Sir William Macewen, who looks on blood-clot as undesirable material to work with for the cure of an aneurism, and directs his attention to thickening the walls of the sac to such an extent as to determine its occlusion, or to prevent its subsequent dilatation. To this end he employs **Acupuncture**, introducing several fine needles into the sac and leaving them to be played upon for a time by the blood-stream, so as to scratch and irritate the further wall of the sac, and thus cause an inflammatory hyperplasia, which shall subsequently organize into dense fibro-cicatricial tissue. The process must be repeated as often as is considered necessary. In his own hands excellent results have been obtained, but whilst admitting its value for internal aneurisms, we cannot but think that for those involving peripheral vessels other methods would be more rapid and equally effective.

\* *British Medical Journal* August 14 1897 *Philadelphia Medical Journal* June 25, 1898

**E Amputation** may be required in the treatment of aneurisms under a variety of circumstances (a) When gangrene of the limb has occurred or is imminent, (b) for diffusion or suppuration of an aneurism when everything else has failed, (c) for secondary hæmorrhage as a last resource, (d) in some cases of recurrent aneurism, (e) when joints have been opened or bones eroded to such an extent as to impair the utility of the limb, and, finally, (f) in a few cases of subclavian aneurism amputation at the shoulder-joint has been practised in order to diminish the amount of blood flowing through the sac

**The Treatment of a Diffuse Aneurism** varies somewhat according to whether the diffusion is slow or rapid In the *leaking* aneurism, which increases in size somewhat slowly, the main vessel leading to the swelling may be tied, if this has not already been undertaken, and the influence of this measure, combined with rest, elevation, and careful general treatment, observed Should the process not be stayed, the case is treated as a diffuse or *ruptured* aneurism by laying open the sac, after exsanguinating the limb by elevation and the use of an elastic band, and securing, if possible, the main vessel above and below, as also any branches which may open into the sac, if they can be found If there is any evidence of incipient gangrene, or if secondary hæmorrhage supervenes, amputation must be undertaken In such cases everything will depend on the efficient maintenance of asepsis

**The Treatment of an Inflamed Aneurism** is always a matter of anxiety from the risk of recurrent and fatal hæmorrhage *If the artery above the aneurism has not been previously ligatured*, it would certainly be correct practice to tie it, and watch the effect produced by that measure, together with rest, elevation, and the local application of an icebag If the inflammatory symptoms still continue, the aneurism should be laid freely open after applying an elastic tourniquet, the coagula turned out, and the main trunk secured above and below If bleeding still continues from smaller branches opening into the sac, the cavity is carefully plugged with strips of aseptic gauze, but a strict watch must be kept over the case, for fear of a return of the bleeding Should this happen, or should gangrene threaten, amputation alone remains *If the main vessel of supply has been previously tied*, the sac should still be laid open and cleared of coagula, all bleeding-points secured if possible, and the cavity stuffed, amputation is, however, likely to be required

### Special Aneurisms

**Aneurism of the Thoracic Aorta**, though of medical rather than of surgical interest, demands a short notice here Any part of the thoracic aorta may be affected, and the symptoms arising therefrom are very variable The fusiform type is most commonly met with in the early stages, a limited sacculature often supervening as the disease advances (1) In the *ascending part of the arch* the swelling



rarely reaches a great size, especially if it is intrapericardial, the sac usually rupturing before marked pressure signs are evident

(2) When arising from the *transverse part of the arch*, the symptoms vary with the direction taken by the enlargement. If it projects *upwards*, a pulsating tumour may appear at the episternal notch, and cerebral effects may then ensue from interference with the circulation through the carotids, or from pressure on the venous trunks. If it extends *anteriorly*, it may form a large tumour with comparatively slight pressure effects, except the pain arising from its erosion of the thoracic wall, it then appears as a pulsating swelling to the right of the sternum. If the enlargement takes place either *posteriorly* or *downwards* within the concavity of the arch, symptoms in the shape of dyspnœa and dysphagia are early produced from the close contiguity of the trachea, œsophagus, and pulmonary vessels. Dyspnœa may also be due to pressure upon the left recurrent laryngeal nerve, causing paresis of the crico-arytenoideus posticus muscle and difficulty in opening the glottis, the voice, moreover, becomes harsh and the cough hard, with what has been described as a 'metallic ring' about it, which is extremely characteristic. Laryngeal or tracheal stridor may be noticed in these cases, and a dragging of the trachea synchronous with the heart's action (the so-called 'tracheal tug')

(3) Aneurisms of the *descending arch and thoracic aorta* often attain considerable dimensions, and may project posteriorly to the left of the vertebral column, causing a pulsating swelling. The only prominent symptoms are pain, due to erosion of ribs or vertebrae, and interference with deglutition, which may be so great as to suggest the presence of an œsophageal constriction, in fact, before a bougie is passed in any case of dysphagia it is always advisable to make certain, if possible, that an aneurism is not present. Auscultation in the left vertebral groove may reveal the existence of a systolic bruit where such a condition exists.

**Treatment**—Little can be done beyond ordinary medical measures, such as rest, diet, and the administration of iodide of potassium. When the tumour could be felt in front, the introduction of coils of iron wire or horsehair has been attempted, and in one or two cases with partial or temporary success, whilst Stewart's method of electrolysis and Macewen's plan of acupuncture have been used with some benefit for supposed cases of sacculated aneurism. Dyspnœa may be at times severe, but *tracheotomy* should never be undertaken, death seldom resulting from this cause.

Surgical treatment, such as *ligature of the right carotid and right subclavian*, or of the left carotid alone, has been adopted in cases of aneurism of the ascending aorta or of the arch. A certain amount of improvement has followed some of the operations, but of eleven cases reported by Kuster, five died within the first ten days. The principles underlying such proceedings are certainly at variance with those guiding our usual treatment of an aneurism, and it is quite possible that the improvement was as much due to the

enforced rest in bed as to the operation. Of course, if the lower end of the carotid is involved in the aneurismal swelling, distal ligature may do some good, as in a case of our own, where the left carotid and subclavian were tied, with a short interval between the operations. The patient's condition improved greatly for a time, and she was able to return to work, but the aneurism finally burst into the left pleura about three years after the first operation.

**Innominate Aneurism** is usually of the tubular variety, and frequently associated with a similar enlargement of the aorta. It presents a pulsating tumour behind the right sterno-clavicular articulation—*i.e.*, between the heads of origin of the sterno-mastoid—projecting either into the episternal notch or outwards into the subclavian triangle, and perhaps pushing the clavicle forwards. The effects produced by its pressure are very variable. The *pulse* in both the right temporal and radial arteries is diminished, *œdema* of a brawny character of the right side of the head and neck, and of the right arm, is caused by pressure on the right innominate vein, whilst less commonly similar changes on the left side may follow compression of the left vein or of the superior vena cava, *pain* shooting into the neck and arm is often produced by implication of the cervical and brachial nerves, whilst hyperæmia of the right side of the face and dilatation of the right pupil may result from irritation of the sympathetic trunk. *Dyspnoea* is induced by direct pressure on the trachea, which may be displaced or flattened, or by irritation of the right recurrent laryngeal nerve, causing partial or complete paralysis of the right vocal cord. *Dysphagia* occurs from pressure on the œsophagus.

The course of the case is slowly progressive, and death most commonly results from asphyxia or from rupture of the sac.

**Treatment**—Rest and the administration of large doses of iodide of potassium may cause improvement, but distal ligature is the most hopeful proceeding. It is obviously impossible to cut off all the blood passing through the sac to the three main divisions—*viz.*, the carotid, subclavian, and vertebral—with safety to the patient (Fig 88). Ligature of any one of these by itself offers but little prospect of improvement, thus, the only case benefited by ligature of the subclavian was

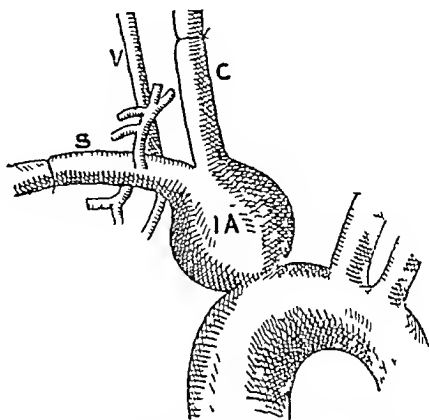


FIG 88—APPLICATION OF LIGATURES FOR INNOMINATE ANEURISM (AFTER ERICHSEN)

IA Innominate aneurism S, subclavian artery, C, carotid, V vertebral artery

one treated by Wardrop, in which the carotid also had been independently and by accident blocked, whilst the only cure recorded after tying the carotid was probably due to subsequent suppuration within the sac (Evans) Ligature of both carotid and subclavian, with an interval of more than a week between the two operations, has practically the same effect as a single ligature, for by that time the collateral circulation will have been established The results following such practice are better than those gained by ligating a single vessel, but not so good as those from tying both vessels at the same time Simultaneous ligature is doubtless the best plan of treatment to adopt, it places the sac in the best possible condition for the deposit of fibrin, whilst the additional step of tying the third part of the subclavian does not materially add to the risk of the operation, which is mainly due to the effect on the cerebral circulation Should operative measures seem undesirable, recourse must be had to Stewart's or Macewen's methods

**Aneurism of the Common Carotid** is usually situated at the upper part of the trunk near the bifurcation, and more often on the right than on the left side The root of the right carotid as it springs from the innominate is also not unfrequently dilated, but the intra-thoracic portion of the left carotid is rarely affected, except in conjunction with aneurism of the aorta No other external vessel is so frequently the seat of aneurism in women

The ordinary intrinsic *signs* of an aneurism are present, and the pressure symptoms are mainly referable to interference with the cerebral circulation, to irritation of the cervical sympathetic trunk, or to pressure upon the larynx, pharynx, or trachea The progress of these cases is usually slow

**Diagnosis** —(1) *From similar disease at the root of the neck* the distinction is often made with difficulty, since either an aortic, innominate, or subclavian aneurism may push upwards so as to simulate it somewhat closely Percussion and auscultation of the upper part of the chest, together with a careful investigation into the history of the case, and a digital examination of the limits of the pulsating mass, may suffice to determine the point Holmes suggests trying the effect of carefully applied distal pressure for a few hours, in a carotid aneurism the tension becomes distinctly less as the collateral circulation commences to enlarge, whilst in an aortic aneurism no difference is observed The *pressure effects* must also be carefully considered 'Pressure on the left recurrent laryngeal nerve would distinguish an aortic aneurism from one on the right vessels, pressure on the right nerve in like manner excludes an aortic aneurism Pressure on the left innominate vein indicates aortic aneurism rather than innominate, compression of the internal jugular or subclavian vein only points to carotid or subclavian aneurism A "tracheal tug" indicates an aneurism of the aorta' (P Gould) The differences in the *peripheral pulses* may also give useful information The two radial pulses should be first examined,

if they are equally affected, an aneurism of the aorta on the cardiac side of the innominate is indicated, if they are equal and normal, an aneurism on the distal side of the origin of the left subclavian. If the left radial pulse is alone aneurismal, the root of the left subclavian is diseased, whilst if the left temporal is also affected, it suggests an aneurism of the transverse part of the arch beyond the innominate. When both radial and temporal vessels on the right side show signs of interference with the pulse, innominate aneurism is probably present, whilst an affection of only one of these branches indicates that the corresponding carotid or subclavian is dilated. One source of fallacy must not be forgotten, viz, that any one of these trunks may be occluded or compressed by a neighbouring aneurism without being dilated, and hence the quality of the pulse must be taken into consideration rather than its actual volume, and to this end the sphygmograph is a useful adjunct in diagnosis. (2) From *abscess, tumours, or enlarged glands* with a transmitted impulse, a carotid aneurism is recognised by an application of the general principles detailed above (p 307). (3) *Pulsating or cystic goitre* may be distinguished from a carotid aneurism by noting that the goitre is not, as a rule, limited to one side of the neck, the isthmus being also involved, that the most fixed part of the tumour is in the median line, and not under the sterno-mastoid muscle, and that the swelling moves up and down during deglutition, an aneurism remaining fixed. (4) An aneurism close to the bifurcation may be simulated by an *abnormal arrangement of the terminal branches*, the external carotid crossing the internal from behind forwards, and being pushed outwards sufficiently to cause a pulsating swelling beneath the skin. This condition is usually symmetrical, and can be recognised by careful palpation.

**Treatment**—*Ligature* of the carotid above or below the omohyoid is the treatment usually adopted, and generally with great success. If the aneurism is near the root of the neck, proximal ligature becomes impracticable, and the distal operation (Brasdor's) must be undertaken.

**Aneurism of the External Carotid** is seldom met with, except as an extension of one involving the bifurcation. The usual phenomena are presented near the angle of the jaw, and well above the thyroid cartilage. Pressure results are early experienced, *e.g.*, paralysis of one side of the tongue through implication of the hypoglossal nerve, aphonia, or dysphagia. In suitable cases, the sac may be dissected out after securing the branches arising from it, as recommended by the late Mr Walsham. Failing this, the common trunk must be tied.

**Aneurism of the Internal Carotid (extracranial portion)** presents symptoms which closely resemble those caused by an aneurism of the bifurcation or of the external carotid, except that the swelling projects more into the pharynx, from which it is separated merely by the pharyngeal wall. It appears as a tense pulsating tumour,

placed immediately under the mucous membrane, and looking dangerously like an abscess of the tonsil. The **Treatment** consists in tying the common carotid.

**Intracranial Aneurism** —Any of the arteries within the skull may become the site of an aneurism, but this condition occurs more commonly upon the internal carotid and its branches than upon those arising from the vertebrals, although the basilar artery is more often affected than any other single vessel. The aneurisms are generally fusiform in character, and their origin is often extremely obscure, a blow or fall being sometimes adduced to explain them, in children they are stated to result from the lodgment of septic emboli. They sometimes grow to a considerable size before causing obvious symptoms, the patient may, in fact, have continued without any manifestation of the disease, until suddenly seized with a rapidly fatal apoplexy from rupture of the sac. If there are any symptoms, they are due rather to compression of the brain than to erosion of the more resistant bony structures. Pain which is more or less fixed and continuous may be complained of, or there may be a feeling of pulsation, or of opening and shutting the top of the skull. Sight, hearing, and other functions of the brain, may also be interfered with, but physical changes in the eyes, such as optic neuritis or atrophy, are not induced, unless there is direct pressure on some part of the optic tract. Occasionally a loud whizzing bruit may be heard on auscultating the skull. The only **Treatment** possible, if a diagnosis can be established, is ligation of the common carotid artery, and even this will be of little use if the basilar is affected.

An **Intra-orbital Aneurism** is recognised by the existence of a pulsating swelling of the orbit, causing protrusion of the eyeball (exophthalmos) and congestion of the conjunctival and deeper vessels. A feeling of pain or tension in the orbit may exist, and gradually vision is impaired, whilst the cornea may become opaque from exposure, due to the inability of the lids to cover it, finally, the whole globe may be disorganized. The symptoms sometimes commence with a definite snap or crack, as though something had given way in the orbit, or they may follow a penetrating injury or a blow. Occasionally the condition is congenital, or arises soon after birth.

Several pathological lesions are included under the title 'intra-orbital aneurism' (a) If congenital, it is probably a case of aneurism by anastomosis. This, however, is not common, being present only in two out of seventy-three cases collected by Rivington, (b) if traumatic in origin, whether due to a penetrating injury or not, the case is probably an aneurismal varix between the internal carotid and cavernous sinus, or a genuine traumatic aneurism of the ophthalmic artery, (c) if idiopathic, it is possibly due to thrombosis of the cavernous sinus, or to spontaneous aneurism of the internal carotid or ophthalmic arteries.

**Diagnosis** —Sarcomata are occasionally met with exhibiting many of the characters of intra-orbital aneurism. Careful palpation will,

however, generally demonstrate the existence of a more definite tumour, and a less-marked expansile pulsation in the sarcoma, whilst the bruit is less distinct. The distortion of the eyeball and ocular axis is often considerable in malignant tumours, but vision is not so early affected.

**Treatment**—Electrolysis and ligature of the common carotid are the only means which hold out any prospect of success, and of these the former should always be first tried. In the congenital cases its application has been very successful, but in those due to trauma it is very likely to fail.

**Subclavian Aneurism** is most frequently seen in men, and particularly those who use their arms much in lifting, such as soldiers and sailors, the right vessel is more often affected than the left. Any part of the artery may be involved, but the greatest dilatation naturally occurs in the third portion. A pulsating tumour develops in the subclavian triangle, which may reach above the clavicle, but chiefly extends backwards, outwards, and downwards, causing pressure effects upon the veins and nerves of the arm, and also hiccough by irritation of the phrenic. Occasionally it encroaches on the dome of the pleura and apex of the lung, and has been known to burst into the pleural cavity. It does not increase in size very rapidly, being surrounded by dense unyielding structures, and never compresses the trachea or œsophagus.

No difficulty presents itself in **Diagnosis** as a rule, although in the early stages it may be somewhat simulated by a normal artery pushed forwards by an exostosis of the first rib, or by a supernumerary cervical rib. A pulsating sarcoma growing from any of the neighbouring structures may also resemble it somewhat closely, but the pulsation is then rarely so limited in extent as in an aneurism, and a definite tumour can usually be felt.

The **Treatment** of subclavian aneurism is surrounded with difficulties, and the results hitherto obtained have been most unsatisfactory. *Extirpation* has been undertaken in one case with success after turning up the middle third of the clavicle, but the aneurism is seldom sufficiently limited to allow of this proceeding. Should any undilated portion of the artery be available outside the thorax, *digital compression on the cardiac side* may be attempted. Direct pressure, manipulation, galvano puncture, and needling the sac according to Macewen's method, have been adopted with occasional success, but cannot be relied on. Stewart's method proved of benefit in one of our cases, the aneurism becoming firmer, and the patient free from pain and able to return home. Unfortunately, he died three months later from hæmorrhage, but no post-mortem examination was obtainable. About 10 feet of gold wire were introduced. *Ligature of the innominate trunk* suggests itself as the operation to be adopted for cure by the Hunterian method, and recent records would certainly encourage one to repeat it in any suitable case, since most of the fatal results occurred prior to the introduction of antiseptic surgery,

\* Moynihan, *Annals of Surgery*, July, 1898

death resulting from sepsis or secondary hæmorrhage. It would appear that the simultaneous ligature of the carotid or vertebral trunks with the innominate is essential to success, in order to prevent the rapid backflow on the distal side of the ligature which otherwise occurs, in addition, the coats of the vessel must be approximated by a broad animal ligature, *e g*, of gold-beater's skin, and not divided.

*Ligature of the first part of the subclavian* has also been attempted for the cure of aneurisms involving the lower part of the vessel, but until recently it was so uniformly fatal that it was considered quite an unjustifiable proceeding, the first nineteen cases all dying. Clutton, however, has reported a successful case, the ligature being applied (without dividing the coats) on the proximal side of the thyroid axis and internal mammary vessels, which were also secured. The first part of the axillary and the superior intercostal had also to be tied before pulsation in the aneurism ceased. Halsted† has since reported a second successful case of this operation. *Ligature of the second part of the subclavian* has been advantageously employed in suitable cases where the aneurism was situated below it. *Distal ligature of the third part* has also been attempted, but without much success.

As a last resource, where the above measures are impracticable or have failed, the plan suggested by the late Sir William Fergusson may be followed, *viz*, *amputation at the shoulder-joint and distal ligature* as near the sac as possible. Distal ligature alone is usually unsuccessful, owing to the fact that the great bulk of the blood needed for the nutrition of the arm still passes through the sac, and there is no means of checking this except by the removal of the limb. A few successful results of such heroic treatment have been reported.

**Axillary Aneurism** is usually the result of falls on the outstretched arm, or injuries to the shoulder, such as fractures or dislocations, or of attempts to reduce them. The **Symptoms** are merely those due to the presence of a pulsating tumour and its pressure, which may cause pain, local and neuralgic, or œdema of the arm. When the upper part of the vessel is affected, a pulsating swelling is felt immediately below the clavicle, whilst if placed lower down it projects more into the axilla, and may totally fill up the hollow. Occasionally the clavicle is displaced upwards, or the aneurism may extend beneath it into the neck, conditions of serious import as regards treatment.

**Treatment**—Compression (digital) or ligature of the third part of the subclavian artery is required, but if the aneurismal sac extends under the clavicle, it may be necessary to secure the second part of the artery, due care being taken of the phrenic nerve.

Aneurisms of the brachial artery, or of any of the vessels of the forearm, require no special notice. They are almost invariably traumatic in origin, and should be treated by extirpation.

**Abdominal Aneurism**—The abdominal aorta may become the seat of aneurism, either at the upper part near the coeliac axis, or at the bifurcation, in the former case, some of the branches arising at that

\* *Trans Med Chir Soc*, vol lxxx, p 391

† *Annals of Surgery*, May 1900

spot are also usually involved, and the disease is of the sacculated type. Occasionally aneurisms form independently on the splenic or mesenteric vessels. A pulsating tumour is observed, usually near the middle line, and either close to the umbilicus or in the epigastric notch, the pulsation is expansile in type, and remains the same in character whatever the position of the patient. Pressure signs are mainly confined to pain, localized in the back from erosion of the vertebræ, or neuralgic from pressure on the solar plexus or lumbar nerves, whilst œdema of the lower extremities may arise from compression of the vena cava. There may be some concurrent derangement of the intestinal functions.

**Diagnosis**—Many conditions give rise to epigastric pulsation, but the majority of them can be readily distinguished from abdominal aneurism by careful examination, if necessary, under an anæsthetic. Cardiac pulsations may be felt in the epigastrium when the heart is dilated, but should be easily recognised, as also an impulse transmitted from the aorta through a collection of fæces or a cancerous growth. The examination of such a case should be conducted not only in the dorsal decubitus, but also in the genu-pectoral position, so as to remove the weight of the viscera from the aorta, when the pulsation will cease or become much diminished. A large accumulation of abdominal fat will seriously interfere with any satisfactory investigation.

**Treatment**—Ligature of the aorta even on the distal side has never yet been attempted for this condition, and hence, failing medical treatment by rest and diet, *compression* was formerly relied on, being applied either on the distal or proximal sides of the sac. The method is, however, clumsy and liable to bruise the abdominal viscera. More recently treatment by needling the sac has been employed, and certainly in Macewen's hands at least one case has been brilliantly successful. There is also one instance on record where the introduction of wire into the sac, combined with electrolysis, cured an aneurism as large as an orange, the abdomen was opened, and electrolysis was maintained for thirty-seven minutes.

**Iliac or Inguinal Aneurism** arises from either the common or external iliac, or from the common femoral, it is frequently sacculated in type, and certain sooner or later to become diffuse. Its shape is determined by the unequal pressure exercised by fascial or other structures, sometimes leading to lobulation. The symptoms are very typical, and pressure effects are mainly experienced in the veins and nerves of the leg. The **Diagnosis** cannot be well mistaken in the early stages, but later on, and specially when situated high in the iliac fossa, it may be difficult to distinguish from a pulsating sarcoma.

**Treatment**—Proximal compression of the aorta or common iliac, where the situation of the swelling and the thickness of the abdominal parietes permit, has had a certain amount of success. It is carried out by means of a tourniquet, shot-bag, or the fingers, and may be advantageously combined with distal pressure. *Ligature of the*



*external iliac* has been frequently performed for inguinal aneurism, and with such success as to warrant its being employed in all suitable cases. *Ligature of the common iliac* is sometimes needed for aneurisms in the iliac fossa. The results of the retroperitoneal operation were by no means satisfactory, but the introduction of the transperitoneal method and the recognition of the importance of not dividing the inner and middle coats in such a large vessel, combined with the use of aseptic animal ligatures, are certain to lead to better results. In ten instances *ligature of the abdominal aorta* has been undertaken for iliac or inguinal aneurism, and in all a fatal issue followed, seven of the patients dying within forty-eight hours, one survived as long as the tenth day, and two lived for forty-eight and thirty-nine days respectively. Of course, wherever practicable, *extirpation* should be resorted to, and at least one successful case has been published.

**Aneurisms of the Gluteal and Sciatic Arteries** are usually traumatic in origin, and present as pulsating swellings of variable size in the buttock, the gluteal situated at the upper part of the sciatic notch, whilst the sciatic lies more deeply, and may be partly intrapelvic. Pulsation is well marked, and murmurs are heard on auscultation. Pain in the limb from pressure on the sciatic nerve is a prominent symptom, especially in the sciatic variety. The **Diagnosis** is by no means simple, especially from a pulsating sarcoma, and many mistakes have occurred even in the practice of eminent surgeons. **Treatment**—The best results hitherto have followed laying open the sac, turning out the clot, and tying the affected trunk—a proceeding requiring operative dexterity and skill of the highest order. Ligature of the internal iliac has also been performed, and with a creditable degree of success, even where the old extraperitoneal method was employed. The use of the transperitoneal route greatly simplifies the operation, and the more recent records of this proceeding are most satisfactory. At the present time it should certainly be undertaken in preference to the plan of laying open the sac.

**Femoral Aneurism** is the title given to one forming in the course of the superficial femoral artery. It is not uncommonly tubular, and occurs almost invariably in males, and as often on one side of the body as the other. The **Diagnosis** needs no discussion, as the disease runs a typical course, and the **Treatment** consists either in extirpation, compression at the groin, or ligature of the common or superficial femoral trunk.

**Aneurism of the Profunda Femoris Artery** is a very rare condition, presenting the ordinary features of a pulsating tumour situated amongst the muscles on the inner side of the thigh, but causing no diminution of the pulse in the popliteal or tibial vessels. The superficial femoral may be felt coursing over it, but quite distinct. Compression by a shot-bag in the groin, or by a tourniquet, may be sufficient to effect a cure, whilst ligature of the common femoral or external iliac may be resorted to, if necessary.

**Popliteal Aneurism** (Fig 89) occurs almost invariably in men, constituting a pulsating tumour in the ham, rendering the knee painful and stiff, and so much do the symptoms resemble those of chronic rheumatism that in every such case the popliteal space should be examined. The limb is usually semiflexed, and the aneurism, which is of a sacculated type, often increases rapidly in size. If the main swelling is situated to the front of the vessel, there is some likelihood of the knee-joint becoming implicated, and neighbouring bones carious, when it extends posteriorly, diffusion is not uncommonly followed by gangrene, on account of the pressure exercised, not only upon the vein, but also upon the articular branches of the popliteal artery, which are most important factors in maintaining the collateral circulation. The **Diagnosis** has to be made from chronic enlargement and abscess of the popliteal glands, but in these there is less disturbance of the circulation in the foot, from bursal tumours, by their want of mobility and pulsation, or from solid tumours, *eg*, pulsating sarcoma of the femur or tibia, from which it can be recognised by attention to the general principles already enunciated. In a few instances spontaneous cure has resulted from the pressure of the sac upon the artery above.

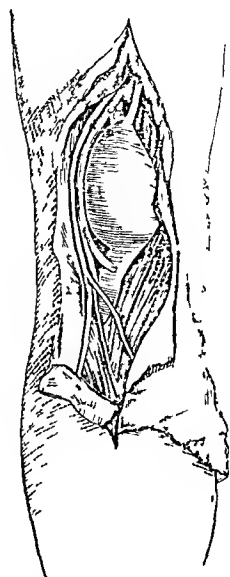


FIG 89 — POPLITEAL ANEURISM

**Treatment**—Compression is eminently successful in many of these cases, whether applied in the groin or by Reid's method. Ligature of the femoral artery at the apex of Scarpa's triangle is, however, the plan most commonly adopted, and with the greatest success. In cases where either of these methods has failed, or where the aneurism has become diffuse or recurred, extirpation of the sac is the best course to adopt.

### Ligature of Vessels

**Ligation in continuity** is an operation performed to arrest the flow of blood to the periphery, in order either to check hæmorrhage, or to promote the cure of an aneurism, or to diminish the rate of growth of some tumour, or to influence beneficially some peripheral organ by reducing its blood-supply, or as a preliminary to removing some vascular structure, such as the tongue.

The **Instruments** needed are as follows: scalpels, dissecting forceps, director or blunt dissector, forcipressure or artery forceps, blunt hooks, retractors for deep wounds, aneurism needle, ligature, needles, and sutures.

The **Material** to be employed for the ligature has been discussed elsewhere (p 280). Sulphuro-chromicized catgut is that most

commonly employed for all but the largest trunks, and for its application to an artery in its continuity the following plan may be adopted. A fine loop of catgut having been passed under the vessel by means of an aneurism needle, a prepared ligature, consisting of three strands of catgut about 10 inches long, knotted together at each end, is threaded through the loop, which is then withdrawn, carrying the ligature under the vessel. The advantages of this method are, that the aneurism needle, being threaded with such fine gut, passes easily and without friction, whilst the use of the loop to draw the ligature back obviates the difficulty, where the artery is deeply placed, of threading the needle if passed unarmed, as is sometimes advised. The substitution of three strands for a single ligature distributes the pressure over a larger area, and is considered more certainly to effect occlusion.

As to the **Operation** itself, the strictest asepsis must be maintained. The artery is examined as far as is possible, so that a healthy portion may be selected for applying the ligature. The various structures met with on the way to the artery are recognised, and drawn, if need be, to one or the other side, so as to lay bare the sheath of the vessel. It is most important that these anatomical landmarks or *rallying-points* should each be seen or felt in order, so that the operator may not be led astray or miss the vessel. Naturally it is easier to find the artery in the living subject than in the dead, the pulsation being of the greatest assistance. The sheath, having been exposed, must now be opened over the situation of the artery by a few delicate strokes of the knife, a portion of the sheath should be picked up between the blades of the forceps, incised along the longitudinal axis, and stripped off the artery, taking care to keep the back of the knife towards the vessel. This incision should be about  $\frac{3}{4}$  inch in length, and should open not only the general, but also the special, sheath of the artery, if such exist. The sheath is then steadied with forceps, whilst the aneurism needle is inserted unarmed, and gently manipulated up and down, so as to free the vessel all round, a matter of no great difficulty if the sheath has been sufficiently opened and the actual arterial wall fairly exposed. The ligature may then be passed through the eye of the needle, and carried round the vessel. It is tied in a direction exactly at right angles to the longitudinal axis, and in doing so the artery must not be dragged out of its sheath, but the ligature should be tightened by the tips of the forefingers meeting upon it. A reef knot is all that is necessary for security in the smaller vessels, but in the largest trunks it may be advisable to employ what has been termed the *stay knot*. Two strands of ligature material are passed round the vessel side by side and half knotted, the two ends on each side are then taken up together and tied across in one knot. The opening in the sheath may be closed over the ligature by a fine buried stitch, and the various structures displaced in reaching the vessel are similarly secured in good position.

The rule usually followed is to pass the needle *from important*

structures, such as the vein, but really this is a matter of little importance when the above directions have been carefully carried out, and especially in superficial vessels. Should the vein be accidentally punctured, the needle must be at once withdrawn, and the puncture in the vein secured by ligature, whilst the artery is tied a little higher or lower. In dealing, however, with the smaller vessels, where the venæ comites are in close contact with the artery, no harm will attend their inclusion in the ligature.

**After-Treatment**—The ordinary antiseptic precautions are taken in regard to the wound, which should be healed and all stitches removed in eight days, but the patient must be kept at rest for some time longer to allow the tissues to consolidate, especially in dealing with the larger vessels and in elderly people. When the main artery to one of the extremities has been tied, the limb should be wrapped in cotton-wool and slightly raised. If there is any likelihood of gangrene, as in the lower limbs of elderly people, the extremity should be thoroughly purified and wrapped in aseptic wool immediately after the operation, in order to avoid septic complications.

There are two great dangers liable to follow the ligation of an artery in its continuity.

1 **Secondary Hæmorrhage** (*vide* p. 286)

2 **Gangrene**, which may arise from a variety of causes. (a) From simple loss of vitality, owing to a defective collateral circulation, as when the peripheral vessels are calcareous and rigid. The tissues which receive the smallest amount of blood die first, *e.g.*, the fingers or toes, or the subcortical white substance of the brain. Severe loss of blood after the operation, as from secondary hæmorrhage, may also determine tissue necrosis. Under such circumstances it almost always takes on the dry form. (b) Interference with the venous return, as by injury to the vein during operation, or the pressure of a tight bandage, or thrombosis induced subsequently by septic periphlebitis, is very likely to cause gangrene, and then it is of the moist type. (c) Injudicious after-treatment, such as too great elevation of the limb, the application of cold lotions, an ice-bag, or fomentations during the period of diminished vitality immediately following the operation, or even an attack of erysipelas, may also bring about the death of some of the tissues.

As soon as there is any suspicion of its onset, the whole limb must be thoroughly purified, and subsequently maintained aseptic. The Treatment of aseptic gangrene following ligation is expectant in character, the parts being allowed to separate naturally. But if there is much pain, or any tendency to spread, or if septic mischief is present, giving rise to fever and general disturbance, it is wiser to remove the limb well above the line of demarcation.

The **Innominate Artery** has now been tied with success on at least six occasions out of a total of about thirty operations. An incision is made along the lower third of the anterior border of the sterno-mastoid, and is prolonged downwards to sweep over the upper edge of the episternal notch. The platysma and the

superficial and deep fasciæ are divided, and the anterior jugular vein secured if necessary between two ligatures, the sterno-mastoid is drawn outwards, and its inner tendinous fibres are divided, whilst the sterno-hyoid and -thyroid muscles are severed close to the sternum and drawn inwards. The carotid sheath is now laid bare and opened at its lower part, so as to expose the carotid artery and enable it to be tied, and by following this downwards the innominate trunk is reached. In some cases it may expedite matters to remove portions of the sternum and inner end of the clavicle. The right internal jugular and innominate veins lie to the outer side of the artery, but if much engorged may project over it, and must then be drawn aside by retractors, whilst the inferior thyroid plexus may course directly downwards to reach the left innominate vein, which crosses the vessel. To the outer or right side and behind the veins are placed the vagus nerve and pleural sac, and these must be carefully separated from the artery, whilst the needle is passed from without inwards, and from below upwards. A double-curved aneurism needle will probably be required to effect this. A broad animal ligature should be used for this vessel, and the inner and middle coats must not be divided.

*Collateral Circulation*—*Inthracinal* Vertebrals and carotids in the circle of Willis

*Face and Neck* Branches of the two external carotids across middle line

*Trunk* First aortic intercostal *with* superior intercostal of subclavian, upper aortic intercostals *with* thoracic branches of axillary and intercostals of internal mammary, deep epigastric and phrenic *with* terminal divisions of internal mammary

The **Carotid Artery** may be tied either above or below the level at which it is crossed by the anterior belly of the omo-hyoid. The line of the vessel is indicated by that drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process, the bifurcation being on a level with the upper border of the thyroid cartilage.

*Ligature above the Omo-hyoid*—This operation is usually chosen, if practicable, since the vessel is here more superficial, the ligature being applied on a level with the cricoid cartilage. The patient lies upon the back, with the chin raised and the head turned a little towards the opposite side. A 3-inch incision is made in the line of the vessel, the centre on a level with the cricoid (Fig 90, D). The skin, platysma, and fasciæ are divided, and the anterior edge of the sterno-mastoid defined as the first rallying-point. The deep fascia is incised along its inner border, so that it may be drawn aside by a retractor, the sterno-mastoid branch of the superior thyroid artery may be divided at this stage, and a vein passing between the facial and anterior jugular may also need to be ligatured. On the inner side of the wound the omo-hyoid muscle must now be looked for, trending forwards and upwards from under cover of the sterno-mastoid. In the angle formed by these two structures the pulsation of the vessel should be felt and the sheath readily recognised, with the descendens cervicis nerve upon it. It is opened on the inner side, and the artery well cleared. The needle is passed from without inwards, and if the sheath has been efficiently opened, the vagus nerve will run no risk of being included.

*Ligature below the Omo-hyoid*—The incision is made in a similar direction to the above, but lower in the neck, reaching from the cricoid cartilage nearly to the sterno-clavicular joint. The sterno-mastoid is drawn outwards, and perhaps the anterior fibres may need to be divided, the sterno-hyoid and -thyroid muscles are retracted inwards or divided, and the omo-hyoid can usually be drawn upwards. The sheath is thus exposed, and opened on the inner side, the needle being passed as in the previous operation. It must be remembered that both internal jugular veins are directed towards the right side in the lower part of their course, and hence the left vein is likely to lie somewhat in front of the artery. The inferior thyroid veins may also be seen, and need to be drawn aside or ligatured.

The *effects* of ligature of the carotid upon the brain are of great interest and importance. Statistics go to prove that in about 25 per cent of the patients operated on cerebral symptoms manifest themselves, either immediately in the form of syncope from cerebral anæmia, or in the course of a few days from

cerebral softening causing paralysis on the opposite side of the body, and even death. A fatal issue is likely to result in about half the cases thus affected. Occasionally a somewhat acute form of congestion of the lungs follows ligation of the carotid within a few hours, possibly due to interference with the circulation in the medulla, or to irritation or injury to the vagus or sympathetics. It may run on to subacute inflammation, and is best remedied by free stimulation or venesection.

*Collateral Circulation*—*Intracranial* Circle of Willis

*Extracranial* Communications across the middle line of branches of the external carotids and vertebrals, inferior thyroid with the superior thyroid, profunda cervicis with princeps cervicis or occipital, superficial cervical with branches of occipital and vertebral.

**Ligation of the Internal Carotid** is rarely needed, but has been employed for hemorrhage and traumatic aneurisms. The ligature is usually placed just above the bifurcation, and the operation is practically the same as for securing the common carotid, only at a higher level. An incision is made along the anterior border of the sterno-mastoid, its centre being opposite the great cornu of the hyoid bone, the muscle is pulled well backwards, and the posterior belly of the digastric is now seen and drawn up. The external carotid is carefully displaced forwards, and then the internal carotid in its sheath appears. The latter is opened, and the aneurism needle passed from the jugular vein.

The *Collateral Circulation* to the brain is maintained by the circle of Willis.

**Ligation of the External Carotid** is occasionally required, the site of election for applying the ligature being between the superior thyroid and lingual branches. An incision is made along the anterior border of the sterno-mastoid, 3 inches in length, its centre corresponding to the great cornu of the hyoid bone. The edge of the muscle is defined and drawn outwards, and the posterior belly of the digastric sought for above, the hypoglossal nerve lying just below it. The sheath is now opened below the tip of the great cornu of the hyoid bone, and the needle passed from without inwards. The operation may be rendered exceedingly difficult by the presence of enlarged glands or veins, especially the lingual, facial, and superior thyroid, which often lie directly in front of the vessel. The superior laryngeal nerve is placed immediately behind it, and must necessarily be avoided.

*Collateral Circulation*—*Vide* ligation of the common carotid (extracranial portion).

**Ligation of the Lingual Artery** is chiefly needed as a preliminary to removal of the organ for malignant disease, it is also occasionally employed in traumatic

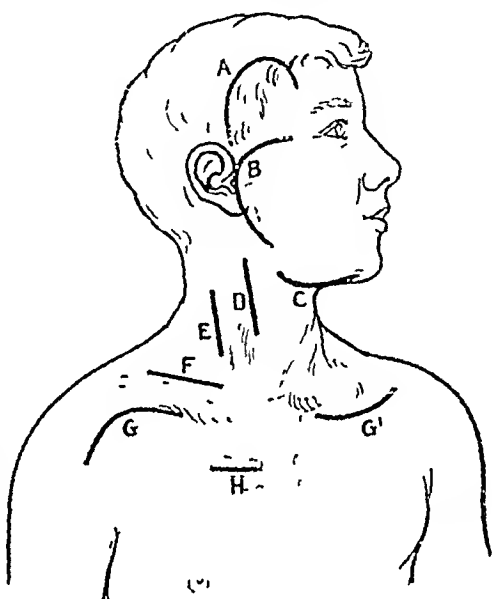


FIG. 90.—INCISIONS FOR VARIOUS OPERATIONS ON HEAD AND NECK.

A, Flap incision used in trephining for meningeal hemorrhage, B, flap incision for operation on roots of the fifth nerve, C, incision for ligation of lingual artery, D, for ligation of common carotid, E, for ligation of vertebral artery, F, for ligation of the third part of the subclavian, G and G', incisions used for tying first part of axillary, H, for ligation of internal mammary artery.

cases The vessel can be secured either close to its origin from the external carotid, or in the submaxillary triangle under cover of the hyoglossus muscle

*In the Submaxillary Triangle*—The patient lies on his back, with the shoulders raised, and the head extended backwards and turned to the opposite side. A crescentic incision is made, commencing about 1 inch below and external to the symphysis menti, and skirting the angle of the jaw, the centre opposite the great cornu of the hyoid bone (Fig 90, C). The integument and platysma are divided, the lower border of the submaxillary gland is defined, and along it the deep fascia is incised. The gland is now drawn upwards, and held over the margin of the jaw with a retractor (Fig 91, Gs). On thoroughly opening up the wound the two bellies of the digastric muscle (*M brv*) are seen converging to the hyoid bone (*Z*), the anterior belly passing superficial to the fibres of the mylo-hyoid muscle (*M mylo*), which course nearly transversely to the mandible, and of which the posterior fibres may be divided with advantage. The digastric tendon is drawn down with a blunt hook, and in the space thus cleared the hyoglossus muscle (*M hyogl*) becomes evident with its fibres passing vertically upwards, and resting upon it the hypoglossal nerve (5) coursing forwards to get under

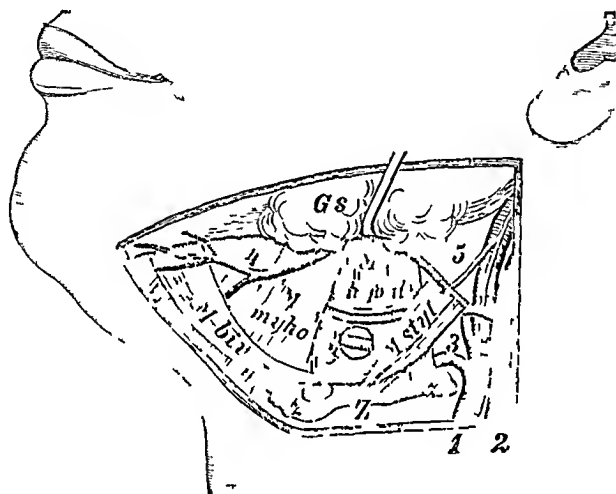


FIG 91—LIGATURE OF LINGUAL ARTERY (TILLMANN'S)

The submaxillary gland (Gs) has been drawn over the side of the jaw with a hook, *Z*, hyoid bone, 1, external carotid, 2, internal jugular, 3, lingual artery, 4, ramine branch of facial, 5, hypoglossal nerve, *M brv*, digastric, *M styl*, stylo-hyoid, *M mylo*, mylo-hyoid, *M hyogl*, hyoglossus. The place where the artery is tied is indicated by a window in the hyoglossus, through which it can be seen.

cover of the mylo hyoid, and either above or below it the ramine vein. The fibres of the hyoglossus are now divided transversely midway between the nerve and the hyoid bone, and in the opening made by their retraction is seen the artery (3), lying on the middle constrictor. Should it not be found in this situation, the incision in the hyoglossus should be extended backwards, and the vessel will then usually come in sight.

*In the Neck close to its Origin*—An incision is made along the anterior border of the sterno mastoid similar to that needed for ligature of the external carotid. The muscle is drawn backwards, and the great cornu of the hyoid bone defined. The small space is now cleared between that bony process and the posterior belly of the digastric, in which the artery can be felt resting upon the middle constrictor, and secured just as it rises from the external carotid.

The **Facial Artery** may be exposed and tied through a horizontal incision, 1 inch in length made directly over the vessel as it crosses the lower border of the jaw immediately in front of the masseter. The platysma will need division, as well as the skin and fascia.

The **Temporal Artery** is reached in front of the auditory meatus, and as it crosses the zygoma, through a vertical incision. It is merely covered by skin and fascia, but must be carefully isolated from the auriculo-temporal nerve.

The **Occipital Artery** is tied through an incision extending from the apex of the mastoid process backwards for about 2 inches towards the occipital protuberance. The posterior fibres of the sterno-mastoid, the splenius, and trachelo-mastoid, are divided so as to expose the artery as it emerges from the groove on the under surface of the mastoid process, where it is easily secured.

The **Subclavian Artery** has been tied in each part of its course, but most frequently in the third. Ligatures of the first and second parts are such unusual proceedings that we must refer students to larger textbooks for descriptions.

*Ligation of the third part* is performed for aneurysm, for hæmorrhage, as a distal operation for tortic or innominate aneurysm, and sometimes as a preliminary to amputation of the upper extremity. The patient is placed on the back, close to the edge of the table, the arm is well depressed, and the head turned to the opposite side. The skin is now drawn down by the left hand, and an incision 3 or 4 inches long made over the clavicle (Fig 90, F). On releasing the skin it retracts upwards, so that the wound comes to be situated about  $\frac{1}{2}$  inch above the clavicle, and thus the external jugular vein is more efficiently protected. The incision should be placed with its centre about 1 inch to the inner side of the middle of the clavicle, and should expose the space between the sterno-mastoid and trapezius muscles, the fibres of which are divided to a suitable extent if they abnormally encroach upon the bone. The skin, superficial fascia, and nerves, with the platysma are divided along the whole length of the incision, as also the deep fascia. The external jugular and other veins now come into view, often constituting a plexus, which may give the surgeon much trouble, they are either drawn aside or, if necessary, divided between ligatures. The cellular tissue is then further incised in the line of the wound, care being taken to avoid the transverse cervical and suprascapular arteries, the former of which is above the line of operation, whilst the latter is hidden behind the clavicle and should not appear. The posterior belly of the omohyoid, if seen at all, is drawn upwards. Various layers of fascia must be carefully cut or torn through until the nerves of the brachial plexus appear, the finger can then readily define the scalene tubercle on the first rib. The subclavian vein is situated in front of the finger, but on a lower level, whilst the artery itself can be detected pulsating under the pulp of the finger between it and the rib. The cords of the brachial plexus are placed above and external to it, the lower cord passing down behind. The needle is insinuated from above downwards and must be kept very close to the artery to prevent all possibility of including the lowest cord of the plexus. The operation in a thin patient may be easy, but in a stout subject, with a short thick neck and high clavicle, the greatest difficulty may be experienced in finding the vessel. The chief dangers arise from wounding the aneurismal sac, the pleural cavity or the superficial veins, whilst the proximity of the cords of the brachial plexus must not be forgotten.

*Collateral Circulation*—*Thoracic set*. Branches of the aortic intercostals and internal mammary with thoracic branches of axillary.

*Scapular set*. Suprascapular and posterior scapular with subscapular and its dorsalis branch in the venter or on the dorsum of scapula.

*Acromial set*. Suprascapular with acromio-thoracic.

The **Internal Mammary Artery** (Fig 90, H) may be exposed and tied by dividing the intercostal aponeurosis and muscles for an inch or more from the outer edge of the sternum, from which margin it is distant about  $\frac{1}{2}$  inch. If the vessel has been divided, and the ends have retracted it may be necessary to excise a portion of costal cartilage in order to secure both ends—a most necessary proceeding owing to the freedom of the collateral circulation and the consequent liability to continued hæmorrhage.



Ligature of the Vertebral Artery has been undertaken for wounds, for secondary hæmorrhage after ligature of the innominate, and in the treatment of epilepsy, but without much permanent benefit in the last case. The operation, though by no means easy, is usually successful as far as the immediate surgical procedure is concerned. An incision is made along the lower half of the posterior border of the sterno mastoid (Fig 90, E), the platysma and deep fascia are divided, a few of the posterior fibres of the muscle itself incised if need be, and its belly drawn well forwards. The scalenus anticus muscle is clearly defined, together with the phrenic nerve. The interval between it and the longus colli muscle can now be demonstrated, with the ascending cervical artery lying upon it. The anterior transverse process of the sixth cervical vertebra must be made out. Just below this the vertebral vessels are found entering the canal in the transverse process, and the vein, which is placed anteriorly, is drawn outwards to allow the needle to be passed from without inwards. A few sympathetic twigs are included in the ligature, and the resulting contraction of the pupil may (according to MacCormac) be looked upon as satisfactory evidence that the vertebral has been in reality secured.

Ligature of the Thyroid Vessels is sometimes used as a means of arresting the growth of a goitre.

The *superior thyroid artery* is tied through an incision along the anterior margin of the sterno mastoid, which has its centre opposite the upper border of the thyroid cartilage; the external carotid is defined, and the superior thyroid secured at its origin.

The *inferior thyroid artery* is reached through an incision along the inner border of the sterno mastoid, extending upwards from the clavicle for 3 inches. This muscle and the subjacent carotid sheath are drawn outwards, the sterno-hyoid and -thyroid usually needing to be divided. The transverse process of the sixth cervical vertebra is sought for, and the vessel found passing inwards immediately below. It is taken up just behind the carotid, and as far from the recurrent laryngeal nerve as possible.

The *Axillary Artery* is tied for punctured wounds of the axilla, as a distal operation for subclavian aneurism, occasionally for wounds of the palmar arch, and possibly for secondary hæmorrhage from the brachial. Two classical operations are described and practised in classes on operative surgery.

1 *Ligature of the first part of the vessel* is usually undertaken through a curved incision with its concavity upwards, extending from the coracoid process to within 1 inch of the sterno-clavicular joint, and  $\frac{1}{2}$  inch below the clavicle (Fig 90 G<sup>1</sup>). The clavicular origin of the pectoralis major is divided, and the costo coracoid membrane exposed and divided along the lower border of the subclavius muscle. Branches of the acromio thoracic axis are displaced downwards and the main trunk is exposed by a blunt dissector and forceps. The vein lies within and below and the cords of the brachial plexus above and to the outer side. The needle is passed from below upwards. The divided muscular fibres should be subsequently sutured together.

An incision which gives an unusually good approach and involves less division of muscular fibres is one which follows the lower border of the clavicle from its centre outwards to the coracoid process and then turns down to lie over the interspace between the pectoralis major and deltoid muscles (Fig 90 G). This intersection is opened up and the outermost fibres of the pectoralis which arise from the clavicle are divided. The costo coracoid membrane is thus exposed, and the cephalic vein will act as a guide to the vessels.

2 *Ligature of the third part of the artery* is performed from the axilla. The arm is fully abducted and the surgeon stands between it and the body. An incision is made in the course of the vessel at the junction of the anterior and middle thirds of the space between the axillary folds (Fig 92, A). The inner border of the coraco brachialis muscle is clearly defined and forms the first rallying-point; it is drawn slightly outwards and the median nerve, together with the musculo cutaneous trunk at once comes into view. On drawing these inwards, the artery itself is seen, with the vein to the inner side, together with the internal cutaneous nerve. The needle is passed from the vein.

*Collateral Circulation*—If above the acromio thoracic, the same as for the third part of the subclavian (q v)

If above the subscapular and circumflex Long thoracic and intercostals with thoracic branches of subscapular suprascapular and posterior scapular with scapular branches of subscapular suprascapular and acromio thoracic with posterior circumflex in the deltoid

If below the circumflex, same as for ligature of brachial above the superior profunda—i e, posterior circumflex with superior profunda in the deltoid

The Brachial Artery may need to be ligatured for hemorrhage from the palmar arches, or from a wound in the forearm or about the elbow for aneurisms, or for arterio venous wounds at the bend of the elbow. It may be tied in one of two places

1 *At the Middle of the Arm*—The arm is held away from the side at a right angle, with the hand supine, but with no support beneath it for fear of pushing forwards the triceps and displacing the vessel. The surgeon stands between the arm and the trunk. An incision 2 inches long is made in the line of the vessel along the inner border of the biceps muscle (Fig 92, B), and the thin fascial investment of the limb divided. The inner edge of the muscle is clearly exposed, and by drawing it slightly forwards the median nerve is brought into view, and perhaps the basilic vein. The nerve, which is at this spot crossing the artery from without inwards, is drawn inwards, and the sheath of the vessel found beneath it. The artery is separated from its venæ comites, and the ligature passed and tied.

The operation is by no means always easy, as there are many traps into which the beginner may fall. Thus the median nerve may cross behind the vessel instead of in front of it, the basilic vein may lie over its situation, and be mistaken for it, or there may be a high division, and two trunks, usually lying close together, must then be sought for instead of one. The most common mistake consists in not defining the biceps muscle, and in seeking for the artery behind its proper situation.

2 *At the Bend of the Elbow*—An oblique incision is made, about 2 inches long, parallel to the inner border of the biceps tendon, its lower end corresponding to the crease of the elbow (Fig 92, C). The incision should be placed at about an angle of forty-five degrees to the axis of the limb, and to the outside of, and nearly parallel to, the median basilic vein, which, if seen, must be drawn inwards. The bicipital fascia is now incised, and the artery with its venæ comites exposed in the loose fat, the median nerve being well away on the inner side. The needle is passed from within outwards.

*Collateral Circulation*—If above the origin of the superior profunda, posterior circumflex in deltoid with ascending branches of superior profunda

If below the origin of the inferior profunda, the anastomoses around the elbow-joint

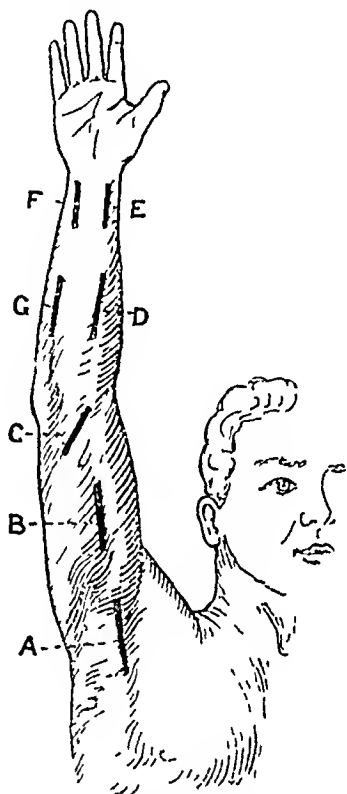


FIG 92—INCISIONS FOR TYING THE ARTERIES OF THE ARM

A, Third part of the axillary B, brachial, C, brachial at the bend of the elbow, D, middle third of radial G, middle third of ulnar, E and F, lower thirds of radial and ulnar

The Ulnar Artery rarely needs ligature except for palmar hæmorrhage or direct wounds. In the former case the artery can easily be secured just above the wrist, in the latter case by enlarging the original wound. The following stereotyped operations are described, but are more often seen in the examination room or dead-house than in the operating theatre. It should be borne in mind that the artery curves inwards from the centre of the bend of the elbow to the radial side of the pisiform bone. The lower two-thirds of its course is indicated by a line drawn from the internal condyle of the humerus to the same spot below.

1 *At the Wrist*—An incision about 1 inch in length is made directly upwards from the flexure of the wrist in the line of the vessel (Fig 92, F). The deep fascia is opened, the tendon of the flexor carpi ulnaris drawn to the inner side, and the vessels are then seen, accompanied by the nerve which lies to the ulnar side of the artery. If possible, the venæ comites should be separated and not included in the ligature.

2 *In the Middle of the Forearm*—An incision is made along a line drawn from the anterior edge of the tip of the inner condyle to the radial side of the pisiform bone (Fig 92 G). The white line indicating the intermuscular septum between the flexor carpi ulnaris and flexor sublimis digitorum is then sought for and opened up, it is often very slightly marked, and may be difficult to distinguish. If the correct interspace has been opened, the surgeon is directed towards the ulna, and readily finds the vessels under cover of the flexor carpi ulnaris, with the nerve lying a little way to the inner or ulnar side. The most common mistake consists in getting too far to the radial side, and in separating various portions of the flexor sublimis, or in passing between it and the palmaris longus. Occasionally, even when the correct interspace has been entered, a beginner may pass beyond the vessels, and find himself between the flexor carpi ulnaris and the flexor profundus.

3 The upper limit of the ulnar artery can be reached through an oblique incision along the upper border of the pronator teres, thus opening up the antecubital fossa, and exposing the bifurcation of the brachial.

**Radial Artery**—The line of the vessel extends from the middle of the bend of the elbow to the interspace at the wrist between the flexor carpi radialis and the supinator longus. It then turns outwards, and may be felt beating in the space described by French anatomists as 'la tabatière' (or snuff-box), between the tendons of the extensor primus and extensor secundus internodii muscles.

1 *At the Back of the Wrist* the vessel may be secured by opening up the above-mentioned intertendinous hollow, where the artery is found coursing onwards to the base of the first interosseous space. An oblique incision is made between the tendons, extending from the back of the styloid process of the radius to the base of the first metacarpal bone. The superficial radial vein is found beneath the skin, and a few twigs of the radial nerve. A deeper layer of fascia is then divided, passing between the tendons, and beneath it the artery is exposed, crossing the incision obliquely. The synovial sheaths accompanying the tendons should not be opened, or some limitation of the movements of the thumb may result.

2 *Above the Wrist* an incision is made in the line of the vessel (Fig 92, E), which is found after division of the fascia between the supinator longus and flexor carpi radialis. The radial nerve has passed to the dorsum ere this, and if any nerve filaments are seen they are derived from the external cutaneous. A small superficial vein usually lies over the artery.

3 *In the Middle or Upper Third of the Forearm* an incision is made in the line of the vessel (Fig 92, D), and the inner border of the supinator longus sought for and retracted. The vessels are found under cover of this structure, with the radial nerve to the outer side, though separated by an interval above.

Ligature of the Abdominal Aorta\* has been undertaken in fourteen instances

\* See Tillaux and Riche, *Revue de Chirurgie*, January, February, and March, 1901.

for severe primary or secondary hæmorrhage, or for diffuse inguinal or iliac aneurism, when no other method of treatment was practicable. All these cases have proved fatal, though one patient operated on by Monteiro in South America survived till the tenth day, whilst Keen's and Killau's lived forty-eight and thirty-nine days respectively. The fatal issue was in most instances due to septic contamination and secondary hæmorrhage, and as the operation has certainly been successful in animals, it is possible that we may yet be able to chronicle a satisfactory result as a triumph of modern surgery.

Two distinct plans of operation have been followed, viz., the *transperitoneal* and the *extra- or retro-peritoneal*, but no one would attempt the latter nowadays. The *transperitoneal* operation consists in opening the abdomen through an incision slightly to the left of the middle line, having the umbilicus on a level with its centre. The intestines are retracted on either side, and the posterior layer of the serous membrane covering the aorta carefully divided, there is then no difficulty in passing a ligature round the vessel. Possibly it would be well to prevent excessive backflow of blood by securing one or both of the common iliac trunks in addition, such would in no way interfere with the collateral circulation.

The **Common Iliac Artery** extends for a distance of 2 inches from the bifurcation of the aorta opposite the left side of the body of the fourth lumbar vertebra to the front of the sacro-iliac synchondrosis. It may be reached in the same way as the aorta by two methods, the *trans* and the *retro-peritoneal*.

In the *retro-peritoneal* operation a curved incision (Fig 93, A or B) is made through the abdominal parietes, somewhat similar to that for ligaturing the external iliac, but extending higher. The muscles and *fascia transversalis* are carefully divided, and the peritoneum, together with its contents, stripped up and held out of the way with a broad retractor. The ureter which crosses the artery is usually carried forwards with the peritoneum. The vessel is now sought for, carefully cleaned, and a ligature passed from right to left (of the patient) on both sides of the body, the vein lying behind the artery on the right side, and behind and internal to it on the left.

The *transperitoneal* plan has already been undertaken with success, and will doubtless henceforth supersede all other methods. An incision is made in the median line with its centre a little below the umbilicus, the peritoneum opened, the intestines retracted, the vessel sought for and exposed by an incision through the posterior layer of the parietal peritoneum, and a ligature passed and tied. The ureter which crosses the artery just above its bifurcation must be carefully avoided.

**Collateral Circulation**—Blood reaches the *external iliac* and its branches by means of the anastomoses of the lumbar arteries *with* the circumflex iliac, and of the superior epigastric, lumbrars, and intercostals *with* the superficial and deep epigastric. The *internal iliac* and its branches are supplied by the union of (a) the lumbar branches *with* the ilio-lumbar, (b) the middle sacral *with* the lateral sacral, (c) the retropubic anastomosis of the two obturator arteries, and (d) the communications of the pudic, hæmorrhoidal, and vesical trunks *with* those of the opposite side.

**Ligature of the Internal Iliac Artery** is occasionally performed for hæmorrhage from, or aneurism of, one of its branches, the gluteal being that most commonly affected. The trunk is a short one, at most  $1\frac{1}{2}$  inches in length, and is best reached by opening the abdomen in the middle line below the umbilicus (Fig 93, C), pushing aside the intestines, and searching for the bifurcation of the common iliac. The posterior layer of the peritoneum is then carefully incised, the ureter avoided, and an armed aneurism needle passed without wounding the vein.

The *Collateral Circulation* is the same as that given for the internal iliac division of the common iliac.

The **Gluteal Artery** occasionally needs to be secured at its point of emergence from the pelvis through the upper part of the great sacro-sciatic foramen. This spot is indicated by the junction of the inner and middle thirds of a line drawn from the posterior superior iliac spine to the top of the great trochanter.

An incision is made in the direction of this line—*1 c*, along the fibres of the gluteus maximus, which are separated and held apart. The deep fascia beneath this muscle is then opened up, and the space between the gluteus medius and pyriformis defined. Through this the upper margin of the sacro-sciatic notch can be detected, as also the pulsation of the artery. The vessel must be secured as deeply as possible on account of its early division. It is always a trouble some dissection, and possibly in most cases it would be wiser to deal with the trunk of the internal iliac from the front.

The **Sciatic and Pudic Arteries** seldom require to be tied, but may be reached opposite the ischial spine, at the junction of the middle and lower thirds of a line drawn from the posterior superior iliac spine to the tuber ischii. An incision

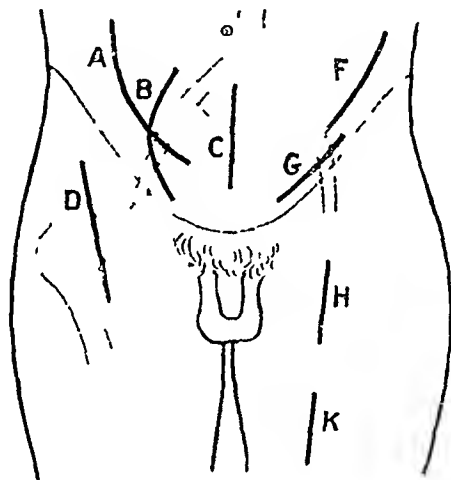


FIG 93—INCISIONS FOR OPERATIONS ON LOWER PART OF ABDOMEN AND UPPER PART OF THIGHS

A, Mott's incision for tying common iliac artery, B, Marcellin Duval's incision for the same, C, incision for transperitoneal ligature of internal iliac artery, D, incision for excision of hip by the anterior method, F, Abernethy's modified operation for ligature of external iliac, G, Astley Cooper's incision for same, H, ligature of femoral artery at apex of Scarpa's triangle, K, ligature of femoral artery in Hunter's canal.

about 4 inches in length is made over this spot, corresponding in direction to the fibres of the gluteus maximus, which are separated. The spine of the ischium and lower border of the pyriformis should now be defined, and the vessels and nerves seen emerging from the foramen. The pudic vessel lies to the inner side of the sciatic, the ligature is passed as high as possible.

The **External Iliac Artery** is easily accessible in any part of its course, which measures from  $3\frac{1}{2}$  to 4 inches in length, it has but few branches, and those situated low down. Its position is indicated by the lower two-thirds of a line drawn from the bifurcation of the aorta to midway between the anterior superior spine and the symphysis pubis—*1 c*, to a point a little internal to the middle of Poupart's ligament.

Many suggestions as to the best means of reaching the artery have been made, and both trans- and extra-peritoneal methods have been adopted. It is so readily secured, however, by the latter that it seems unnecessary to open the peritoneum. There are two chief forms of extraperitoneal operation.

**Astley Cooper's Operation**—An incision is made parallel to the outer half of

Poupart's ligament, commencing a little to the inner side of its centre, and  $\frac{3}{8}$  inch above it, and extending upwards and outwards to about 1 inch internal to the anterior superior spine (Fig 93, G). The external oblique aponeurosis is divided along this line, and the exposed lower margins of the internal oblique and transversalis muscles arching over the inguinal canal are drawn upwards by retractors. The transversalis fascia and loose subperitoneal fat are now opened with forceps and director, and the vessel is felt pulsating immediately under the finger. It is very important not to damage either the epigastric or circumflex iliac arteries during this manipulation, since they are most essential factors in establishing the collateral circulation, whilst the circumflex iliac vein crossing the main trunk must also be avoided. The needle is passed from within outwards, the ligature tied, and the divided muscular and aponeurotic structures united by buried sutures.

*Abernethy's Modified Operation* is more commonly utilized. The incision, about  $\frac{1}{2}$  inches in length, extends from a point  $1\frac{1}{2}$  inches within and above the anterior superior iliac spine to just external to, and  $\frac{1}{2}$  inch above, the middle of Poupart's ligament (Fig 93 F). Through this the aponeurosis of the external oblique is divided along the course of its fibres, as also the internal oblique and transversalis. The transversalis fascia is now carefully incised, it varies considerably in thickness, being sometimes well developed, but is occasionally so attenuated as to be scarcely recognisable, and in such cases the peritoneum may unintentionally be opened. In the present day this is an accident of slight importance, the wound being readily closed by a continuous suture, and no harm resulting. The fingers are now introduced into the wound, and the peritoneum and its contents stripped from the iliac fossa, and drawn inwards and forwards, where they are kept out of the way by a broad spatula. In the space thus opened up one can see the iliacus muscle covered by its fascia, and to its inner side the rounded outline of the psoas. The vessel lies to the inner border of this, and can usually be readily found, enveloped in a fascial sheath, with the genito-crural nerve coursing over it, and perhaps some lymphatic glands upon it. The artery is separated from the vein which lies to the inner side, and the needle passed from within outwards. If the transversalis fascia has not been properly opened, it is quite possible to strip it up together with the peritoneum, and carry the vessels forwards with it, when they may be found under cover of the spatula.

On comparing the two operations, we are very distinctly in favour of the latter plan. By Cooper's method the artery is tied very close to important collateral branches, whilst but a small portion of the trunk is exposed, so that if this is diseased and unsuitable for the application of a ligature, no further choice is possible. In Abernethy's, on the other hand, the vessel is tied well away from collateral branches, and if the exposed portion of the trunk is diseased, the common iliac can be reached and secured without much difficulty by extending the incision upwards. As to the greater tendency to hernia stated to exist in this method, this may have been the case in pre-antiseptic days, when the muscles were not sutured for fear of retaining septic discharges, but careful asepsis, the use of buried sutures, and the possibility of doing without drainage tubes, should render such a sequela impossible.

*Collateral Circulation*—*Anterior set* Superior epigastric of internal mammary, lumbar, and lower intercostals *with* superficial and deep epigastric in sheath of rectus.

*Posterior set* Gluteal and sciatic *with* internal and external circumflex and first perforating of profunda at back of great trochanter (circual anastomosis).

*External set* Ilio lumbar and gluteal *with* deep and superficial circumflex iliac and ascending branch of external circumflex.

*Internal set* Obturator *with* internal circumflex, and terminal divisions of internal pudic *with* superficial and deep external pudic.

The **Common Femoral Artery** is but rarely ligatured, except as a preliminary measure in amputation at the hip-joint, since the number of branches arising from it is likely to interfere with its sound occlusion, and the collateral circulation is better after ligature of the external iliac. It may be reached by a vertical incision over the line of the vessel extending both a little above and below Poupart's ligament. The superficial lymphatics and veins must be carefully avoided

the fascia lata divided, the sheath exposed and opened, and the ligature passed from the inner side

*Collateral Circulation*—*Internal set* Obturator with internal circumflex, and internal pudic with external pudic

*External set* Circumflex iliac with ascending branch of external circumflex

*Posterior set* Gluteal and sciatic with internal and external circumflex, and first perforating, comes nervi ischiadici with perforating of the profunda and musculi of popliteal

The **Superficial Femoral Artery** is indicated by a line drawn from midway between the anterior superior spine and the symphysis pubis to the tuberosity of the internal condyle, the limb being flexed, adducted, and a little everted. It may be secured at 'the site of election'—i.e., at the apex of Scarpa's triangle—or in Hunter's canal

*Ligature at the Apex of Scarpa's Triangle*—A 4 inch incision is made in the line of the artery, the centre being about 4 inches (or a hand's breadth) below Poupart's ligament (Fig 93, H). The integument and fasciæ are divided, the inner border of the sartorius exposed, and the sheath found immediately behind it, the muscle being drawn slightly outwards, the middle cutaneous nerve is perhaps brought into view. A muscular branch to the sartorius may be met with at this spot, and should be separately ligatured. The vein is placed behind the artery, so that the needle may be passed either way, special care being taken to keep it close to the vessel

*Collateral Circulation*—External circumflex with lower muscular of femoral, anastomotica magna, and superior articular of popliteal

Profunda femoris by its perforating and terminal branches with the muscular and articular branches of femoral and popliteal

*Ligature in Hunter's Canal*—An incision 4 inches in length is made along the line of the artery in the middle of the thigh (Fig 93, K). The sartorius is exposed by division of the fascia lata, its fibres running downwards and inwards, its outer border should be defined, and the muscle retracted inwards. The aponeurotic covering of Hunter's canal is now in view, stretching between the adductor longus and vastus internus, it is incised, and the sheath of the vessel found below it, with the nerve to the vastus internus lying to its outer side, the long saphenous nerve crossing it from without inwards, and the vein passing behind it, to become external lower down. The needle may be passed in either direction, and the ligature should not be placed too low on account of the contiguity of the anastomotica magna. A common mistake made by students in tying this artery on the dead subject is to burrow down along the vastus internus on the outer side of the vessels, this is to be avoided by always keeping close to the under surface of the sartorius until the glistening transverse fibres of Hunter's aponeurosis are clearly visible

*Collateral Circulation* is maintained through the profunda and its branches

The **Popliteal Artery** may be tied either just after it has passed through the adductor opening, or in the depths of the popliteal space, but preferably in the former situation. Neither operation is often required

To tie the *upper part* the limb is fully abducted and everted so as to enable the adductor tubercle and tendon of the adductor magnus to be clearly defined. An incision, 4 inches in length, is then made from the tubercle upwards (Fig 94, A), and the tendon exposed. The internal saphenous vein and nerve may be seen, but are drawn backwards by means of a broad retractor, together with the sartorius, gracilis, and semi-membranosus. If possible, the branch of the anastomotica magna which courses along the tendon should be spared. The fascial space behind is now opened up, and the artery found surrounded by a good deal of loose connective tissue. The vein is usually seen on the outer side, and is here very thick and dense, so that in the dead subject it can be readily mistaken for the artery

The *lower part* is tied through an incision in the middle line of the popliteal space, dividing the deep fascia and drawing out of the way the heads of the gastrocnemius muscle and the internal popliteal nerve. The vein is superficial to the artery, and is found by following the short saphenous trunk. The needle is passed from the inner side

*Collateral Circulation* is maintained by the anastomoses around the knee-joint

The **Posterior Tibial Artery** but seldom requires to be ligated except for hæmorrhage, or on the face of amputation stumps, hence the operations described below are rarely seen away from the dead-house. The line of the vessel is indicated by one drawn from the centre of the popliteal space to a point a finger's breadth behind the internal malleolus

1 *In the Middle of the Calf*—The leg is placed on its outer side and flexed, and an incision 4 inches long is made 2 finger's breadth behind the inner border

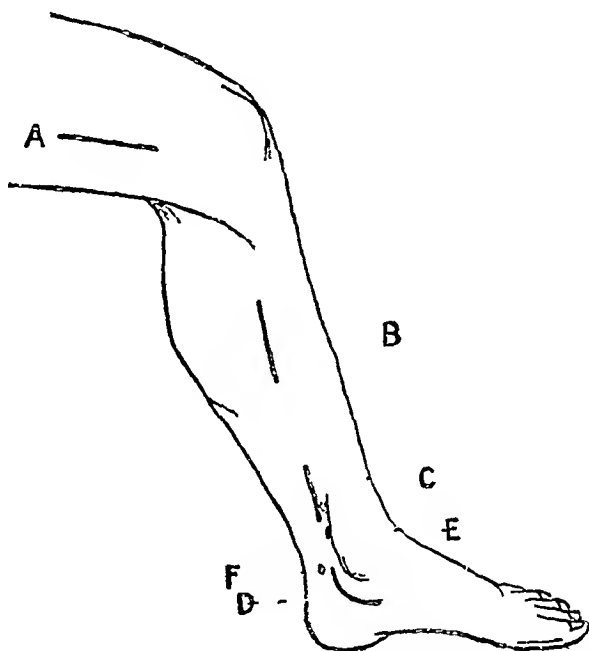


FIG 94—INCISIONS FOR LIGATURE OF THE UPPER PART OF THE POPLITEAL (A), AND OF THE POSTERIOR TIBIAL ARTERIES (B, C, AND D)

E, Site for Introduction of Knife in Tenotomy of Tibialis Posticus,  
F, Ditto for Tendo Achillis

of the tibia (Fig 94, B), dividing the skin and subcutaneous tissues, the long saphenous vein and nerve being drawn aside if necessary. The tibial origin of the soleus is thus exposed, and incised directly towards the tibia, until the fibrous aponeurosis on its deeper surface is met with. This having been cut through, the muscle is drawn backwards with the retractor, and the vessels, ensheathed in a deep layer of fascia, are seen lying on the tibialis posticus, and with the posterior tibial nerve to the outer side. The venæ comites are separated, if possible, and the ligature passed from the nerve. Sometimes the above mentioned aponeurosis is in the substance of the soleus, and a thin layer of muscular fibres exists on its deeper aspect.

2 *In the Lower Third of the Leg*—An incision is made midway between the tendo Achillis and inner border of the tibia (Fig 94, C). The skin and fasciæ, including the upper part of the internal annular ligament, are divided, and the vessels seen lying on the flexor longus digitorum, with the nerve behind and to the outer side.

3 *Behind the Malleolus*—An incision is made about a finger's breadth from the malleolus, curving round its lower border (Fig 94, D). The deep fascia (or,



as it is here termed, the internal annular ligament) is divided over the vessels between the tendons of the flexor longus digitorum and flexor proprius hallucis, and the artery is then readily cleared and ligatured. The sheaths of the tendons should not be opened.

The **Anterior Tibial Artery** is found along a line stretching from a point midway between the outer tuberosity of the tibia and the head of the fibula above to the central point between the two malleoli below. It may be tied in three situations:

1 *In the Upper Third of the Leg*—An incision is made exactly in the line of the artery (Fig 95, A), and the deep fascia incised. The intermuscular space between the tibialis anticus and the extensor communis digitorum is opened.

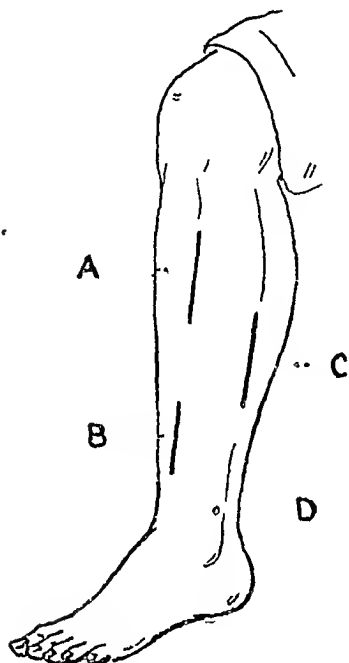


FIG 95 —INCISIONS FOR LIGATION OF ANTERIOR TIBIAL (A AND B) AND PERONEAL (C) ARTERIES. D, SITE FOR INTRODUCTION OF KNIFE IN TENOTOMY OF PERONEI.

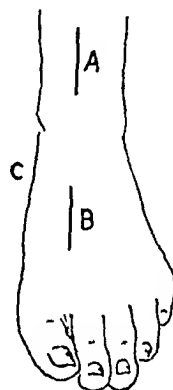


FIG 96 —INCISIONS FOR LIGATION OF LOWER PART OF ANTERIOR TIBIAL (A) AND DORSALIS PEDIS (B) ARTERIES. C, SITE FOR PERFORMING TENOTOMY OF TIBIALIS ANTICUS.

The vessel lies between these muscles upon the interosseous membrane, the anterior tibial nerve being to the outer side.

2 *In the Middle of the Leg* (Fig 95, B)—The same intermuscular space is opened, being indicated here by a definite white line, due to a slight subfascial deposit of fat. The vessels lie between the tibialis anticus and the deeply-placed extensor proprius hallucis, the nerve usually lying on the artery and needing to be drawn aside.

3 *In the Lower Third of the Leg*—An incision is made in the line of the artery, reaching upwards for 2 inches from a point just above the ankle (Fig 96, A). The deep fascia and upper part of the annular ligament are divided, and the vessel is found between the tendons of the tibialis anticus and of the extensor proprius hallucis, the nerve lying to the outer side.

The **Dorsalis Pedis Artery** extends from the centre of the line between the two malleoli to the interval between the bases of the first two metatarsal bones. An incision is made in this direction (Fig 96, B), the deep fascia opened, and the artery found lying between the *extensor proprius hallucis*, which has now crossed and is internal to the vessel, and the innermost slip of the *extensor brevis digitorum*. It is not always easy to find, and for practical purposes the best plan would be to divide the vessel by an incision extending to the bones, and then pick up and tie the bleeding ends.

The **Peroneal Artery** can be reached through an incision along the posterior border of the centre of the fibula, the leg being laid on its inner side (Fig 95, C). The outer edge of the soleus is defined and drawn inwards, the lower fibres of attachment to the fibula being divided if necessary. The *flexor longus hallucis* is thereby exposed, and incised in such a manner as to allow the surgeon to reach the postero-internal border of the fibula, the artery is then readily found lying in an osseo aponeurotic canal.

## CHAPTER XIII.

### SURGERY OF THE VEINS

#### Thrombosis

By **Thrombosis** is meant intravascular coagulation in any part of the circulatory system. Normally the blood remains in a fluid condition, owing to some inter-action between it and the vessel walls. Any factor producing a disturbance of this normal equilibrium may determine thrombosis, and any part of the vascular tract may be affected by it, whether the heart, arteries, veins, or capillaries. We have already discussed some of the conditions associated with capillary or arterial thrombosis, that which follows, whilst referring primarily to venous thrombosis, is also in a measure true of the other forms.

**Causes**—(1) *Changes in the vessel walls*, as a result of which the integrity of the endothelium is disturbed—e.g., injury (either division, rupture, puncture, compression, or contusion), inflammation or degeneration (as in varicose veins).

(2) *Changes in the constitution of the blood*, whereby its coagulability is increased. Excess of excretives, as after pregnancy during involution of the uterine walls, may have this effect, or the presence of toxins arising from bacterial activity, hence septic diseases are commonly associated with thrombosis. Great loss of blood up to a half of the whole amount in the body also increases its coagulability, but excess of leucocytes, as in leukæmia, has the opposite effect. A. E. Wright has shown that the percentage of calcium chloride in the blood is an important factor. If 0.6 per cent of this salt is present, coagulation is hastened, and he has proposed to reduce the loss of blood during operations to a minimum by injecting into the rectum half an hour previously a pint of warm water containing 2 ounces of this salt in solution. In one or two cases in which we have seen it used, it appeared to be efficacious, but its general utility is doubtful, since it might lead to coagulation in unwished-for localities.

(3) *Diminished rate of the blood-stream* predisposes to thrombosis if some other condition is present to determine it. Lister showed years ago that blood can remain fluid for a long time if confined in a tube formed of a suitable length of the vein wall, but when either of the preceding factors is present, a retardation of the blood-stream

materially assists in causing coagulation. Thus, when a vein is pressed upon by a tumour, the obstruction to the blood-flow produces a clot at the spot where the nutrition of the wall is interfered with. After fevers, such as typhoid or rheumatic, where the character of the blood is somewhat altered and the action of the heart weakened by changes in the muscular fibres, the defective *vis-a-tergo* causes a retardation of the flow in the veins, as a result of which the intravenous pressure is diminished, and the valves are only partially pushed back, spaces being left behind them in which the blood stagnates. Coagulation is probably determined by some slight injury or pressure which is not noticed by the patient, or by some lessened vitality of the wall of the vein, or by disintegration of the leucocytes and setting free of fibrin ferment owing to the defective circulation. The clots thus formed behind the valves gradually increase in size until the whole lumen of the vessel is obstructed.

The *white leg* of the puerperal woman, or, as it is sometimes termed, *phlegmasia alba dolens*, is sometimes induced in the same way, although it is probable that in most cases the coagulum extends to the femoral vein from the uterine plexuses. A similar condition occurs during or after appendicitis, and may then be due to the direct action of inflammatory phenomena around the iliac vein, if it involve the right leg, but curiously enough the left leg is much more frequently affected in this as in every other condition. It may occur after any form of operation, and is generally associated with sepsis of some type or other, though perhaps of a very mild description. The clotting may gradually spread upwards, even to the vena cava.

The **Character** of the clot varies according to whether it is deposited slowly or is due to a rapid coagulation of the blood. In the former case the so called *White Thrombus* is met with, which is formed upon, and adheres to, the vessel wall, and gradually increases by fresh deposits of fibrin until it entirely blocks the channel. If a certain number of red corpuscles are entangled in the meshes of the clot, it is termed a *Mixed Thrombus*, the more rapid its formation, the greater the number of red corpuscles present. Should the blood coagulate *en masse* in a vein, as after its total division or ligature, an ordinary *Red Thrombus* is produced, which at first is not adherent to the wall, but becomes so later on, especially at its base. A similar type of clot is usually found *post-mortem* capping any white clot which has formed previously.

The **Effects** of thrombosis may be considered under the following headings: local, distal, and proximal.

**Locally** (a) The clot may be organized into connective tissue, a fibrous cord replacing the vessel in the same way as was described for arterial thrombosis (p. 276). (b) The lumen of the vein may be re-established by cleavage and shrinking of the thrombus to one side of the vein wall, or by canalization of the clot or of the fibrous cicatrix replacing it, owing to the dilatation of the vessels contained within. (c) The clot may soften, disintegrate, and be washed away in minute particles into the circulation. If this is unattended with

sepsis, no harm need follow, but if septic in origin, local abscesses, or even diffuse suppuration, may occur along the vein, together with general pyæmia (d) The clot may shrink or become loosened in an ampulla of a varicose vein, forming a fibrinous mass which is subsequently infiltrated with calcareous particles, constituting a vein-stone or *Phlebolith*

**Distally**, congestion of the terminal veins is caused by the obstruction to the circulation, and if a main trunk is affected, œdema of the limb follows, and possibly ulceration or gangrene. It must be remembered, however, that if the condition affects the femoral vein of a person in the recumbent position, there may be very little or no œdema as long as the limb is kept up. The diagnosis must then be

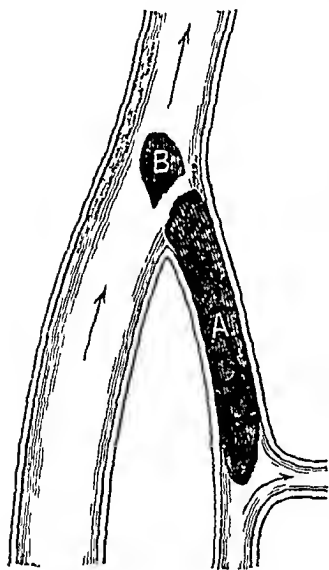


FIG 97 — THROMBUS AND EMBOLUS (KEEN AND WHITE)

A, Thrombus *in situ* B, embolus detached from the same

made by the pain along the course of the vein, which can be felt as a hard cord. In favourable cases the collateral circulation is soon established by the opening up and dilatation of other venous channels, which after a time may become varicose, and if situated superficially, are often very obvious. Thus, if the common femoral or external iliac vein is occluded above Poupart's ligament, the internal saphenous and superficial epigastric veins become distended and varicose, and the latter may be seen coursing up the abdominal wall towards the umbilicus, and uniting with the same branch on the opposite side to find its way to the saphena vein of that limb. If the inferior vena cava is obstructed, the mammary and epigastric veins become dilated and tortuous, standing out prominently on the anterior abdominal wall.

**Proximally**, the process may gradually extend upwards, and finally involve larger and more important trunks than that in which it originated. Moreover, a portion of a thrombus may be detached as an *Embolus* (Fig 97, B). If the clot is under-

going molecular disintegration and only minute portions are set free, they are filtered off by the lungs or kidneys, and no symptoms need be caused. If, however, a large portion is detached, urgent dyspnoea and even death occur from obstruction to the pulmonary vessels and subsequent arrest of the circulation. If the clot becomes septic and fragments conveying organisms are carried into the circulation, pyæmia is the result, preceded, however, in the portal area by pyle phlebitis—i.e., suppurative phlebitis of the portal trunks in the liver.

The **Clinical Signs and Treatment** of venous thrombosis are the same as for phlebitis (*q v*)

## Embolism

An **Embolus** is the term applied to any foreign body which travels for a greater or less distance in the bloodvessels until it becomes lodged within them and causes obstruction. There are four main varieties of embolus: (a) **Simple Emboli**—e.g., blood-clot, granulations or fibrinous vegetations from the cardiac valves after acute endocarditis, atheromatous plates, air-bubbles, fat globules, etc. (b) **Infective Emboli** consist of either zoogloea masses of bacteria or disintegrated portions of blood-clot carrying micro-organisms and originating a pyæmic abscess wherever they lodge. (c) **Malignant Emboli** are formed by portions of some malignant growth, from which the various secondary deposits originate, such are met with more frequently in the sarcomata than in the carcinomata. (d) **Parasitic Emboli** also occur, such as the ova and scolices of the *Trema ichnoscoccus* and the *Filaria sanguinis hominis*.

Emboli may be detached from the heart, veins, or arteries, although necessarily they are never arrested in a systemic vein, but only in the arteries or portal vein. They are of all sizes, and the character of the resulting symptoms depends much on this. A large embolus started in a peripheral vein lodges in one of the branches of the pulmonary artery, and may cause instant death, a smaller one is arrested in one of the smaller arteries of the lung and may do but little harm, whilst minute ones may possibly pass through the pulmonary capillaries to the left side of the heart, and subsequently become impacted in the systemic vessels.

**Effects of an Embolus**—The local effects of the lodgment of a simple embolus consist, firstly, in the deposit of fibrin upon it, rendering the obstruction complete, organization of the thrombus usually follows, although occasionally it may disintegrate and disappear. Under these circumstances a weak spot may be left in the arterial wall, from which an aneurism is subsequently developed. The local effects of infective, malignant, and parasitic emboli are dealt with elsewhere.

The distal effects of embolic obstruction depend entirely on the relation of the vessel blocked to the surrounding circulation.

(1) Should the embolus be lodged in an artery which gives off anastomotic branches below the point of obstruction, or if the capillary anastomosis is abundant, a **transient anæmia** is all that occurs in most cases. If the artery is small, or goes to unimportant structures, no symptoms need arise from this, but if the vessel is large, or supplies delicate and important tissues, serious results may follow even a temporary arrest of the circulation, thus, embolus of the central artery of the retina always causes permanent blindness, although the retina still lives.

(2) Should the embolus block what Cohnheim called a 'terminal artery' (i.e., one with no anastomosis between the embolus and the terminal capillaries), or a vessel with insufficient collateral circulation, the obstruction will lead to death of, at any rate, a portion of the anæmic region—e.g., gangrene in a limb, or white or yellow softening in the brain. In an organ such as the kidney or spleen, the result of embolic obstruction to one of the terminal arteries is the development of what is known as an **infarct**—i.e., a wedge-shaped area of tissue with the blocked artery at its apex becomes devitalized, and in consequence looks white and feels firmer than the surrounding parts. The tissues cannot be properly stained for microscopic purposes. Sometimes the anæmic area becomes engorged with blood to such an extent as to lead to extravasation, and a firm, solid patch of a dark-red colour results, known as a **hæmorrhagic infarct**. Whatever its appearance, the infarct is subsequently invaded by granulation tissue developed from the surrounding healthy parts, and this finally results in the formation of a depressed cicatrix containing, perhaps, a few hæmatoidin crystals. The conditions necessary for the production of an infarct are met with in the lungs, spleen, kidney, and brain, in the liver the anastomosis is generally too free to allow of its formation, although it has been known to occur.

**Effects of the Lodgment of Emboli in Various Organs**—In the **Brain**, the middle cerebral artery is most commonly blocked, resulting in immediate hemiplegia, which may be almost entirely recovered from, but commonly leaves some impairment of function. In children the symptoms are less marked but aneurism of the affected vessel occasionally follows. In the **Central Artery of the Retina**,

sudden, total, and irremediable blindness is produced, the branches of the vessel are seen to be almost empty, the retina becomes œdematous, the macula alone retaining its normal colour, appearing as a cherry-red spot, contrasting markedly with the pallid œdematous tissues around. In the **Lung**, fatal results supervene from obstruction to a large vessel, whilst, if a smaller one is blocked, a certain amount of pain and dyspnoea is produced, followed by the formation of an infarct, as indicated by dulness, bronchial breathing and bronchophony. In the **Liver**, an embolus of the hepatic artery causes sudden hypochondriac pain, and perhaps a passing glycosuria. The portal vein and its branches are not unfrequently obstructed by emboli, which, being usually of a septic nature, give rise to pyæmic symptoms (pylephlebitis). In the **Spleen**, a sudden pain in the left hypochondrium is experienced, the organ becomes enlarged, and a considerable rise of temperature may follow. In the **Kidney**, sudden pain in the loin and a temporary hæmaturia constitute the main symptoms. In the **Intestine**, localized ulceration or extensive gangrene is likely to follow, according to the size of the vessel obstructed. In the **Limbs**, the emboli usually lodge at the bifurcations of main vessels, often saddling across the fork, and blocking both branches. Sudden pain is felt at the spot, shooting downwards, and either recovery or gangrene ensues (p. 100).

### Phlebitis

Phlebitis, or inflammation of the vein wall, arises from a variety of causes, and is not uncommon in surgical practice. The following forms may be described.

1 **Simple Phlebitis**, in which a more or less *localized* inflammation of the wall of a vein is attended by thrombosis. It extends for a variable distance up and down the vessel, but usually not further than the next patent branches. (a) It may arise from *injury*, either subcutaneous or open, or from the continued pressure and irritation of a tumour or aneurism, (b) it may be *idiopathic* in nature, attacking the larger veins of the lower extremity, or vessels which have been long subject to varix, especially in gouty individuals. (c) It may follow primary thrombosis, either in a main trunk or in a varicose peripheral vein, or (d) it may be induced by inflammation of the tissues around the vein (*periphlebitis*), usually of septic origin.

2 **Infective Phlebitis** is a much more serious condition, inasmuch as the thrombus resulting therefrom is always invaded by micro-organisms, and the disease is often of a *spreading* type. It was this form of phlebitis which in the old days so commonly followed operations, and made surgeons fear any interference with veins, it has now been almost banished as a sequela of surgical operations by antiseptics, and there is no more fear of dealing with veins than with any other tissue of the body. It may, however, arise (a) in traumatic cases where asepsis has not been attended to or has failed, the organisms invading the clot which lies in the open mouth of the vein, or (b) as a result of septic periphlebitis in wounds, or in septic inflammation of bones, such as when a septic mastoiditis leads to disease of the mastoid emissary vein and of the lateral sinus. The usual results are localized or spreading suppuration in the course of and around the vein, and general pyæmia. (c) It may possibly be induced by auto-infection of the clot present in simple phlebitis.

The **Morbid Anatomy** of phlebitis shows nothing unusual, the walls of the vein are congested and thickened, and the endothelial

lining is hypertrophied, the thrombus contained in the vessel varies in its characters. If infected, it becomes soft and pultaceous, resembling dirty-looking pus, a localized abscess may form, or the suppuration may extend for some distance along and around the vein. In the more favourable cases the spread of the infection is limited by the terminal portions of the clot remaining firm and unaffected.

The **Symptoms** of inflammation of a **superficial** vein are sufficiently obvious. The vessel becomes swollen, hard and painful, with localized enlargements or knobs corresponding to the valves or to the pouches in varicose veins. The skin over them is dusky and congested, and there may be some œdema of the region from which the blood flowing in the vein is gathered, this, however, rarely amounts to much, since the collateral circulation is always abundant. If suppuration occurs, the signs of a localized abscess are noted, on opening this, care must be devoted to maintaining the part aseptic, in order to prevent, as far as possible, the extension of the inflammation.

When the **deeper** veins are involved, it may be impossible to detect them on palpation, although a blocked common femoral is easily felt, but acute deeply-seated pain over the vein and well-marked fever are characteristic evidences of what has occurred. Œdema of a more or less solid character develops, although if the limb is maintained in the horizontal position throughout the attack this need not occur. Obliteration of the vessel, and any of the local, distal, or general processes detailed under thrombosis (p. 343), may result.

The onset of **Septic Spreading Phlebitis** is marked by fever and perhaps rigors, whilst the local signs are due to the rapid extension of a suppurative inflammation along the vein and its branches, so that a large tract of tissue is very quickly invaded, and diffuse suppuration follows. The development of pyæmia would be indicated by a repetition of the rigors.

**Treatment of Simple Phlebitis**—The limb must be kept absolutely at rest to limit the inflammation and to prevent the detachment of emboli, and also elevated to assist venous return. Locally, belladonna fomentations may be applied, or the parts may be painted with glycerine and extract of belladonna, swathed in a thick layer of cotton-wool, and lightly bandaged. The patient should be kept on an unstimulating though nutritious diet, and the general health attended to. When every sign of inflammation has subsided, and sufficient time has been allowed for the absorption or organization of the clot (six to eight weeks), massage may be commenced, to assist in the removal of œdema and local thickening, and an elastic bandage is usually serviceable in restoring the circulation. Operation is sometimes undertaken in cases of phlebitis associated with varix, but not when the deeper veins are involved. If abscesses form, they must be opened antiseptically.

**Spreading Infective Phlebitis** is treated by following up the suppurative process with the knife, laying open the tissues around the involved veins. The wounds thus made should be treated with peroxide of hydrogen and lightly stuffed, at the same time, the limb



is raised and kept absolutely quiet. Should pyæmic phenomena develop, it may be possible to place a ligature between the disintegrating clot and the heart, and to scrape or wash away the septic mass, thus in septic thrombosis of the lateral sinus, following supuration in the middle ear, the internal jugular vein should be ligatured, the lateral sinus opened, and the clot removed. Of course, such treatment is only feasible in cases where a single trunk is affected. When the process affects the veins of a limb, and cannot be stopped by either of these plans of treatment, the question of amputation may even have to be raised.

### Varicose Veins, or Varix

A vein is said to be varicose, or in a condition of varix, when it has become permanently lengthened, dilated, and more or less tortuous. The superficial veins of the leg, especially the internal and external saphena, are those most commonly affected, the spermatic veins are often in a similar condition, constituting what is known as a varicocele, whilst piles are primarily due to varicosity of the hæmorrhoidal plexus. We shall here only deal with the first of these three manifestations.

**Causes** —Varix is probably due, in the first place, to some congenital weakness of the venous wall, or irregularity in the arrangement of the valves, though possibly this produces no effect until some exciting cause comes into action and throws a strain on the circulation. The facts that varicose veins are hereditary, even the same vein being often involved in different members of a family, and that varix sometimes appears quite early in life, and without adequate cause, confirm this hypothesis.

As exciting causes may be mentioned any condition which leads to a frequently repeated or more or less permanent distension of a vein, such as prolonged standing, as in those serving behind counters, the pressure of tight garters, especially if worn below the knee, prolonged or forcible exertion of the limb, as possibly in cyclists, whereby the blood is driven from the deeper into the more superficial veins, the pressure of a pregnant or displaced uterus, or of a pelvic tumour. Obstruction to and occlusion of the deeper veins is another well-recognised cause of varix, and we have already drawn attention to the effects produced by blocking of the common femoral vein and inferior vena cava. A less known instance is the varix of the internal saphena or some of its branches below the knee which follows thrombosis of the *venæ comites* of the posterior tibial, due to strains of the leg and similar injuries. If the thrombus is absorbed, the dilatation disappears, but if the block is permanent, the superficial veins become varicose, usually extending to just below the knee. Any abnormal communication between an artery and a vein also causes varicosity, from the inability of the latter to withstand arterial blood-pressure (*vide* Aneurismal Varix, p. 296). The tendency to varix increases with age till the middle period of life is reached, and is

favoured by the relaxation of the system resulting from sedentary habits. When once a vein has become varicose and its walls are thin and expanded, the valves become incompetent, and the superincumbent weight of the blood tends to still further increase the mischief.

**Morbid Anatomy**—To the naked eye a varicose vein in an early stage appears thickened, distended, and tortuous, the walls are so thick that the vein when cut across does not collapse, but presents a gaping mouth, like an artery, the valves atrophy, and are functionally useless. After a time the walls become further stretched and irregularly expanded, forming here and there large pouch-like dilatations, which are very obvious under the attenuated skin, to which they are often adherent. Microscopically, the change consists in a transformation of the normal structures of the vein wall into fibro-cicatricial tissue. The tunica media is mainly affected, most of the muscular fibres disappearing, whilst the tunica intima is but little changed, and the adventitia thickened. In the pouches the middle coat is atrophied, and, indeed, is often completely absent.

**Clinical History**—The enlarged veins are seen ramifying under the skin with a more or less tortuous and serpentine course (Fig 98), and they often feel thickened. One or more veins may be affected, and the tortuosity may be at parts so marked as to constitute large clusters of dilated vessels, which look bluish under the attenuated skin. Should the upper end of the internal saphena be involved, it is almost always dilated so as to form a large pouch, which opens by a wide mouth into the femoral vein.

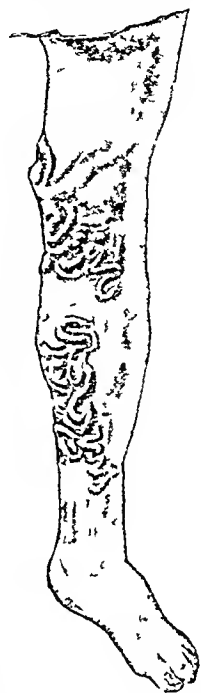


FIG 98—VARIX OF INTERNAL SAPHENA (FROM A PHOTOGRAPH)

The **Effects** of this condition are very varied. The circulation in the lower parts of the leg may be impaired, especially that of the skin. The limb feels heavy and painful, forcible exertion may cause a sensation of tension, and after standing or exercise there is usually a little œdema of the ankle. The capillaries in the papillæ often become dilated, appearing as minute reddish puncta, which subsequently run together and form brownish patches of pigmentation. Eczema is induced by the irritation of rough and coarse trousers or dirt, often terminating in actual ulceration. Any lesion, such as a scratch or abrasion, instead of healing readily under a scab, tends to spread and form an ulcer. Injury to the vein may lead to thrombosis and spontaneous cure, but coagulation sometimes occurs idiosyncratically in the pouches, especially in gouty subjects. The clot may subsequently shrink and form a small fibrinous or calcareous mass, known as a 'phlebolith,' but sometimes the thrombosis spreads into deeper or larger veins, and then

fragments of clot may be detached as emboli. Occasionally the dilated pouch of a varicose vein gives way, and an alarming gush of blood results, the same may follow the extension of ulceration through the vein wall. The blood under these circumstances is derived, not only from the lower, but also from the upper end, inasmuch as the valves have become incompetent, a column of blood extending from the right auricle is thus tapped near its lower end, and, unless prompt precautions are taken, the patient's life may be lost.

The **Treatment** of varicose veins may be described as palliative and radical.

**Palliative Treatment** consists in removing any source of obstruction in the shape of tight garters, in limiting the amount of standing, in moderate massage, together with the application of either an elastic stocking or an indiarubber bandage. The bowels should be kept well open, and the general health attended to. Eczema may be treated by the application of soothing and drying ointments, *e.g.*, ung. zinci benzoatis, or if the skin is chronically infiltrated and thickened, by the use of weak tarry applications, *e.g.*, ol. Rusci (1 part to 4 of vaseline), or of ichthyol (5 or 10 per cent. in vaseline). Varicose ulcers are treated on ordinary principles, or by Unna's method (p. 89), but repair is often delayed till the veins have been dealt with by operation.

**Radical Treatment** consists in the excision of the distended veins. Before operating it is important to make certain that the condition is not due to thrombosis of the deep trunks, as interference would then do more harm than good, and the vein would be certain to recur in neighbouring collateral veins. Operation is specially indicated when thin, dilated pouches exist, when elastic stockings cannot be comfortably worn, as in the tropics, when ulcers exist which refuse to heal, when the condition is very extensive and painful, and especially if large bunches of dilated veins are seen, or when there is a distinct impulse or thrill on coughing, indicating that the valves which protect the veins of the leg are defective. It may not be practicable to remove all, but if the largest and most prominent are taken away, the others will probably shrink and disappear. There are two chief plans of doing this. (a) Small portions are removed at several different situations. The skin is pinched up over the vein, and incised by transfixion, the vessel is usually bared by this means, but may need a little cleaning. An aneurism needle is passed beneath it, and the vein isolated sufficiently to allow of its being grasped by two pairs of forceps, and divided between. Each end is now freed, and drawn out of the wound as far as possible, it is then ligatured and removed. Probably  $2\frac{1}{2}$  inches of vein may be taken away through a 1-inch incision. The wound is sutured without drainage and dressed. (b) Long incisions are made, perhaps 6 inches or more, through which larger clusters of veins may be dealt with. The wound should not lie over the most dilated parts of the vessel, as there the skin is often thin and unhealthy, but should be curved so as to include as much sound skin as possible, whilst crossing the vessels once or

twice. All collateral branches, especially the deep ones, must be secured, and this, in fact, constitutes the great advantage of the operation, viz., that so many anastomosing channels are obliterated. (c) A simpler procedure has been advocated by Trendelenburg, viz., the removal of a portion of the internal saphena high up, so as to break the weight of the superjacent column of blood. In many cases, but especially where there is an impulse on coughing, it is a most valuable measure, though the enlarged veins lower down should also be excised. (d) When varix involves the upper end of the internal saphena, which is dilated to constitute an ampulla, it is scarcely advisable to attempt removal of the pouch, as the communication between it and the main trunk is so short and wide that the application of a ligature becomes risky, and a sudden rise of intravenous pressure, as by vomiting, might force off the ligature. The vein must be tied below the pouch, which will become contracted, with or without clotting of its contents, when the blood-current is deflected.

After an operation for varix the patient should remain in the recumbent posture for three weeks, to allow clots to become firm and to permit the circulation to accommodate itself to the new arrangements. On first rising from bed, it is well to support the limb for a time by an elastic stocking, indiarubber bandage, or, better still, by a 'Crêpe Velpeau' bandage.

**Inflamed Varicose Veins** are not unfrequent, and may result in a natural cure of the condition. The symptoms are those of a superficial phlebitis, and the treatment indicated for that condition should be followed. In cases where there is much pain it may be justifiable to excise the thrombosed vessels, taking the precaution first to secure by ligature the vein above the clot, so as to prevent any risk of embolic detachment. Operation of a similar type is also required when thrombosis is gradually spreading upwards, and threatening to affect the deep trunks, e.g., in the neighbourhood of the saphenous opening, or when portions of clot are being detached as emboli, giving rise to pulmonary symptoms.

**Hæmorrhage from a Ruptured Vein** needs prompt and decisive treatment. The bleeding spot should be commanded by digital compression, and the patient laid on the back with the limb elevated, until either a pad of antiseptic dressing can be applied to the wound, or a handkerchief or bandage secured over it.

### Nævus

A nævus is a vascular tumour developing in the skin or mucous membrane and in the underlying tissues, and consists of a congeries of vessels held together by connective tissue. Nævi are of congenital origin, or develop soon after birth. Left to themselves, they may shrink and disappear, but more often they increase in size more or less rapidly, whilst sometimes they remain passive and persist through life. Two chief varieties are described.

The **Capillary Nævus** (or mother's mark) occurs in the form of a

slightly raised flattened mass, bright red or purple in colour, according to the relative amount of arterial or venous blood present, and with occasionally a somewhat irregular or nodulated surface, in which larger vessels may be seen ramifying. It consists merely of a mass of capillaries lined with endothelium communicating with a few arterioles and venules, and held together by loose connective tissue. Several such growths may be present in the same individual, and they are usually quite small, not exceeding an inch or two in diameter, though sometimes they extend widely over the face and neck, and are then very superficial in character, and somewhat dusky in colour, constituting the 'port-wine stain'. If cut into, they bleed freely, but the hæmorrhage is easily stopped by pressure.

Occasionally a nævoid development may be observed involving half the body, and limited almost exactly by the middle line, this condition is known as *nævus unius lateris*. It may consist of a purely vascular manifestation, or the skin may be hypertrophied and covered with small soft papillary excrescences.

**Treatment** is usually simple in the extreme. Small superficial nævi can be completely cured by some form of cauterization, such as the application of the electric or actual cautery, ethylate of soda, or nitric acid, in applying fluid caustics, the surrounding skin must be protected by a thick layer of vaseline. In exposed situations electrolysis (*vide infra*) is the best plan to adopt in order to prevent the formation of a scar, but excision will often give an equally good result.

The **Cavernous or Venous Nævus** most commonly involves both skin and subcutaneous tissues, but is sometimes purely subcutaneous. It consists of a more or less prominent swelling, soft to the touch, and easily compressible, but refilling when the pressure is removed. There is no pulsation or bruit, and the mass may be lobulated. If subcutaneous, the skin over it is somewhat bluish in colour, but the mixed forms are dusky red. Occasionally it may undergo spontaneous cure from inflammation and thrombosis, and cysts are sometimes found in the centre of a nævoid mass, indicating that a partial attempt at this process has occurred. Venous nævi consist of a collection of vascular spaces lined with endothelium, some tubular like veins or capillaries, others mere pouches, held together by fibrous tissue. The arterial supply is not very great, but the arteries usually open directly into the venous spaces without the intervention of capillaries (p. 198).

The **Treatment** is by no means as simple as in the former variety. The following plans may be mentioned.

- 1 **Excision** of the growth should always be adopted where practicable. Cases which formerly were dealt with by strangulation are now treated by this means. The bleeding is never great, even if the nævoid tissue is encroached upon by the knife, and only a few vessels will need to be tied. Circular growths should be removed by crescentic incisions, and a little undercutting will usually enable the edges to be easily approximated. In exposed situations Halsted's subcuticular suture should be employed.

- 2 The **Injection** of coagulating and irritating fluids, such as per-

chloride of iron or pure liquefied carbolic acid, has been employed, but has no advantages over electrolysis, and is more risky and less certain in its results

3 Where excision is impossible, or where it is important to leave no scars or only minute ones, **Electrolysis** should be employed. It consists in the passage of a current of high electromotive force through the mass, producing chemical and physical changes in the contained blood. A Stohrer's battery can be used, or any suitable collection of cells, connected in series. Both needles may be inserted into the mass, but it is sometimes wiser only to introduce one or more needles connected with the positive pole, whilst the negative pole is attached to a large electrode moistened and placed on some indifferent part of the body, such as the arm, back, or thigh. The needle is often with advantage made of iron or steel, since it is usually corroded, and the chloride of iron thus formed acts beneficially in determining coagulation of the blood, it must be carefully and thoroughly insulated when deep *nævi* are treated, so as to protect the skin and prevent the current passing through it. The use of the negative pole is more likely to produce scarring, since a caustic sodium compound is formed around it, and this may lead to sloughing of the tissues, the clot, moreover, is loose and spongy, whilst a much firmer coagulum occurs around the positive pole. If the positive pole alone is introduced, a current equal to about 200 milliampères, as measured by a galvanometer, may be passed for ten or fifteen minutes, if both poles are used, a current half this strength is sufficient. An anæsthetic is needed, and the immediate effect should be to make the mass feel hard and firm by the coagulation of the blood, organization of the thrombus leads to obliteration of the vascular spaces and disappearance of the tumour. The application may require to be repeated several times, and the needles should be freely worked about through the mass. Not uncommonly the child becomes pale and faint if the *nævus* is on the head, probably as an effect of the strong current upon the cerebral centres. For the treatment of superficial *nævi*, there is no necessity to have the needle coated, it is introduced into the mass in a number of places, especially where any definite vessels are seen, and of course does not penetrate deeply. A very short application of the current usually suffices at each puncture, the *nævoid* tissue turns white, and there is a little bubbling of gas around the needle. It is best to deal first with the periphery of a *nævus*, and then, when its extension is arrested, the central parts can be treated. Of course, some scarring cannot be avoided, and hence it is wise not to do too much at one sitting, and to make the intervals sufficiently long to allow cicatrization to take place.

A **Nævo-Lipoma** is the name given to a somewhat rare tumour, in which a fatty element is blended with *nævoid* tissue. It is usually of congenital origin, or, at any rate, appears early in life, and is probably due to the undifferentiated formative cells of the embryo developing in a twofold direction, so as to produce not only fatty connective tissue, but also vessels. It gives rise to a swelling,

lobulated and doughy, like a fatty tumour, although it is usually a little denser in texture than the ordinary lipoma. It may be possible to reduce its size by compression, but no thrill or pulsation can be detected, a few dilated veins or capillaries are often seen on the surface. The only treatment is excision.

### Venesection

Venesection or phlebotomy is a means of treatment which has largely fallen into disuse of late years, but is still occasionally employed with benefit. When a patient is becoming cyanosed, and asphyxia is threatening either (*a*) as a result of pulmonary engorgement from mitral incompetency, owing to the heart being unable to drive the blood into the systemic circulation, or (*b*) as a consequence of some accident involving the chest-wall and lungs, whereby the blood-aerating surface is so diminished that it cannot deal with the blood reaching it through the right side of the heart, which hence

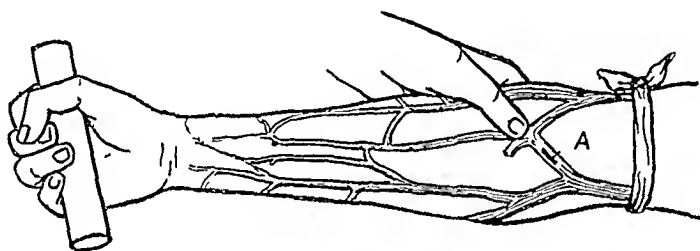


FIG 99 — VENESECTION

becomes enormously distended, and threatens to stop in a condition of diastole or (*c*) where inflammation of the brain is pending, and the pulse is hard and full, or (*d*) in many inflammatory states in strong, full-blooded individuals where the pulse-tension is high—in any of these conditions venesection may be used with advantage.

The median basilic vein at the bend of the elbow is that usually opened, since it is larger than the median cephalic, though placed more directly over the brachial artery, from which it is only separated by the bicipital fascia.

**Requisites**—A strip of bandage about 4 feet long, a lancet, a graduated bleeding-bowl, and finally a stick or bandage to be grasped by the hand, so as to cause contraction of the muscles, thus pressing the blood from the deep into the superficial veins along the communicating branch which enters the median just below its bifurcation.

**Operation**—The patient should be seated in a chair, standing would produce syncope too rapidly, whilst the recumbent posture would allow too great an abstraction of blood before Nature's danger-signal (*ie*, syncope) is evident. The skin in front of the elbow having been purified, as also the fingers of the surgeon and the lancet, the bandage is tied round the arm with sufficient tight-

ness to arrest the venous circulation whilst the arterial supply is unimpeded. Grasping the stick firmly causes the veins to become prominent. The median basilic is now steadied by the left thumb, and an incision made into it (Fig 99, A). Blood will flow from it in a full stream, and is collected in the bowl. When sufficient has been withdrawn, the stick is removed from the patient's hand, the surgeon's thumb is placed over the bleeding spot, the bandage above is relaxed, and a pad of antiseptic dressing placed over the wound and firmly bandaged in position, the arm is kept at rest for a few days to allow the small incision to heal. Occasionally neuralgic pain is caused by the implication of some of the fibres of the internal cutaneous nerve in the cicatrix, whilst, if the lancet is plunged too deeply, an arterio-venous wound may be produced.



## CHAPTER XIV

### DISEASES OF THE LYMPHATICS

#### Affections of Lymphatic Vessels

**Acute Lymphangitis, or Inflammation of the Lymphatic Vessels**, results almost invariably from the absorption along the lymphatics from an impure wound of septic material, which gives rise to irritation and inflammation of the surrounding tissues, and this may run on to suppuration. The process is usually limited by the nearest lymphatic glands, which filter off the toxic products, but occasionally it spreads beyond them, and causes a true septicæmia. Dissecting or post mortem wounds are not unfrequently of this nature.

**Morbid Anatomy** —The walls of the lymphatics become hyperæmic and infiltrated, and the tissues around are inflamed. The lymph is said to coagulate in the vessels, forming a pinkish clot.

**Clinical Signs** —The characteristic appearance is that of fine red lines or streaks following the course of the lymphatics, perhaps up to the nearest glands, the parts thus inflamed are tender and œdematous. If the mischief is limited to the main trunks (*tubular lymphangitis*), these red lines remain isolated from each other, but if all the smaller lymphatic channels of a part are affected (*retiform lymphangitis*), the redness merges into a generalized blush, and the condition is practically identical with cellulitis. Localized foci of suppuration often follow, the redness increasing and the parts becoming dusky and brawny, until finally the centres soften and fluctuate. These phenomena are associated with fever and malaise, the temperature rising to 102° or 103°, possibly attended by rigors, vomiting, and diarrhœa.

Under suitable treatment resolution rapidly follows, but suppuration may occur either in the glands or in some loose mass of cellular tissue traversed by the lymphatic trunks, or as a chain of abscesses in the course of the vessels. Occasionally the lymphatic vessels become permanently occluded, and a form of solid or lymphatic œdema results. Recurrent attacks of this type are not uncommon in connection with chronic eczema or ulcers of the leg, and may lead to a form of elephantiasis. In a few cases the patient dies from general septicæmia, or from exhaustion following diffuse suppuration.

**Treatment** is first of all directed to the causative focus, which must be thoroughly purified, so as to cut off the supply of irritating toxins to the lymphatics. The limb itself is kept at rest in a slightly elevated position, and either irrigated with cold lotions, or treated with belladonna fomentations. Abscesses are opened as soon as they develop. Any subsequent oedema of the limb is remedied by massage and firm bandaging, provided no venous complications are present.

Constitutional treatment consists in the administration of a purge, followed by quinine and tonics, care being taken that constipation is not thereby produced. A light and nutritious diet is ordered, together with stimulants, if necessary.

**Chronic Lymphangitis** either results as a sequela of an acute attack, or is met with as a separate condition. It is most frequently seen in connection with venereal disease, the dorsal lymphatics of the penis becoming enlarged, hard, and cord-like, especially in cases of primary syphilis. This is usually accompanied by a solid oedematous condition of the prepuce and enlargement of the inguinal glands. Under appropriate antisyphilitic treatment, the swelling quickly subsides.

A *tuberculous* type of chronic lymphangitis also exists in which a primary focus, say, on a finger is associated with secondary deposits along the lymphatics up the arm. Each nodule is at first of firm consistency, but gradually softens and breaks down. Naturally, such a case is liable to be followed by general dissemination. The *treatment* consists in the excision, if possible, of each focus.

The cheeks and nose are occasionally the seat of a chronic relapsing lymphangitis, due to the absorption of sepsis from sores or ulcers within the nostril. It is characterized by patches of hyperæmia and some amount of tissue infiltration, and for its cure the causative sores must be dealt with. The thick lips of a tuberculous child are of a similar nature, and due to the constant irritation of cracks along the lip margin.

**Rupture or Division of the Thoracic Duct** during operations on the neck is manifested by an escape of chylous fluid, which coagulates on standing, if the flow continues, exhaustion quickly follows. Cases, however, have been published showing that the condition is not necessarily fatal, and that if the wounded vessel can be secured, as by ligature or forcipressure, recovery may ensue. In such instances the thoracic duct probably opens by several mouths into the subclavian vein, and only one of the branches has been injured.

Lymphatics, like bloodvessels, are liable to distension and dilatation, which may be either congenital or acquired, and are known as **Lymphangioma** or **Lymphangiectasis**. It is impossible to draw an absolute line of distinction between the two conditions, but the latter term is applied mainly to cases where normal lymphatics are dilated and their continuity with the normal lymphatic circulation persists, whilst a lymphangioma is the result of a new formation. Of course, the two conditions may develop side by side.

**Lymphangiomata** are growths composed of newly-formed lymphatics, together with a variable amount of connective tissue, which is sometimes of a markedly fatty nature. They may be congenital or acquired, but even in the latter case there is probably some underlying congenital element, which was only awaiting some irritation or localized injury to determine its development. Two varieties may be described, the capillary and cavernous.

(a) The **Capillary Lymphangioma** is usually congenital in origin, but often increases considerably as the child grows, and may attain large proportions. When developing in the skin, it may be termed a **lymphatic nævus**, and in origin and development it well merits the title. The patch is usually of a dull yellowish-brown colour, but this varies with the amount of blood present, it may be smooth-topped like a wheal, or warty in appearance, but on examination with a lens each projecting point contains a vesicle. This type of growth is sometimes very extensive, and may be associated with tumours of the underlying connective tissues. We recently removed a large fatty mass from the anterior thoracic wall of a child, the greater portion of the projecting surface of which was covered with a capillary lymphangioma. The only *treatment* for this condition is excision or destruction by a caustic.

In the subcutaneous tissues the capillary variety is often associated with large cysts of the cavernous type. It constitutes a soft swelling which when cut into has a spongy texture and exudes a large amount of lymph, with some blood. This form is rarely well defined, and may burrow widely, invading and infiltrating the tissues, and, indeed, in some cases may almost be looked on as of a malignant nature. Free excision is the only cure.

(b) **Cavernous Lymphangioma**—The lymphatics here lose their tubular condition and give rise to cyst-like swellings which vary much in size.

In the skin they are rarely larger than a split pea, and may co-exist with the capillary variety. Any part of the body may be affected, and the lesion manifests itself as a series of small vesicles, which persist and are unaccompanied by any inflammatory redness, thus serving to distinguish it from herpes. They contain lymph, and, if opened, a considerable flow of this fluid (lymphorrhœa) may result, lasting for some time. They have been observed most frequently on the inner side of the thigh and on the prepuce. **Treatment** consists in excision, or in laying them open and cauterizing the base.

In the deeper structures large multilocular cystic swellings may be produced, these are most frequently seen in the neck, and the condition is often termed a **Cystic Hygioma** (Fig 100). The description given in Chapter XXXI would apply equally well to a tumour of this nature in any other part of the body. Removal by dissection is often very difficult, especially in old-standing neglected cases, the limitations of the mass are sometimes very indefinite, and it may be

\* See Carless, 'Some Cases of Lymphangioma,' *Brit Journ of Children's Diseases*, February, 1904, p 56

necessary to leave the wound open and pack it, so as to ensure healing by granulation

**Lymphangiectases** are more frequently acquired than congenital, but the latter condition occurs, and is then probably due to some abnormal development of the lymphatics or to ante-natal inflammatory mischief

**Macroglossia** and **macrocheilia** are congenital enlargements of the tongue and lip, due to lymphatic obstruction and to an associated over growth of the connective tissues of the parts

In a few cases the opening of the *thoracic duct* has been obstructed or compressed, leading to such backward tension that the receptaculum chyli has ruptured and the peritoneal and pleural cavities have been filled with a serous or chylous exudation Virchow described one case where the opening was congenitally absent (in a calf) and the lymphatics throughout the body were enormously distended, especially those of the small intestine

The condition known as **Chylous Hydrocele**, in which there is an effusion of milky fluid (presumably chyle) into the tunica vaginalis,



FIG 100—CYSTIC HYGROMA OF NECK (FROM A PHOTOGRAPH)

The patient was a child of a few weeks. The cyst was opened and the mass partially removed. Recurrence ensued, and a further operation of a very extensive character was required. As the lymphangiomatous tissue had invaded the sterno mastoid and parotid gland, it was impracticable to remove it totally. The child finally succumbed to septic lymphangitis and exhaustion

is probably due to some such obstructive cause. In a case under our care the lymphatics of the spermatic cord were dilated by a similar fluid in a beaded manner

**Elephantiasis** is a hypertrophic condition of the subcutaneous tissues and skin resulting from chronic lymphatic obstruction. Two chief varieties are described (1) *E arabum*, due to a development in the lymphatics of living parasites, viz, the *Filaria sanguinis hominis*, (ii) the *non-filarial* type, which may arise from many causes, such as the deposit of tuberculous or cancerous material in lymphatic glands, the obliteration of lymphatic channels in operations for removing such glands, recurrent attacks of lymphangitis in cases of chronic eczema or ulcer, leading to a gradually increasing obliteration of lymphatics. The condition generally affects the legs, but the scrotum

is not uncommonly involved, and occasionally the mammæ, arms, or face. The accompanying illustrations (Figs 101 and 102) indicate that the non-filarial type may be just as severe as the other, although this is unusual.

Three chief phenomena manifest themselves as the outcome of such obstruction, viz., (a) *Solid or lymphatic œdema*, a condition in which the subcutaneous tissues become firm, infiltrated, and brawny, but the fluid cannot be expressed from them, as in an ordinary œdema, (b) *hyperplasia* follows, affecting not only the subcutaneous tissues, which are markedly thickened and increased in amount, but

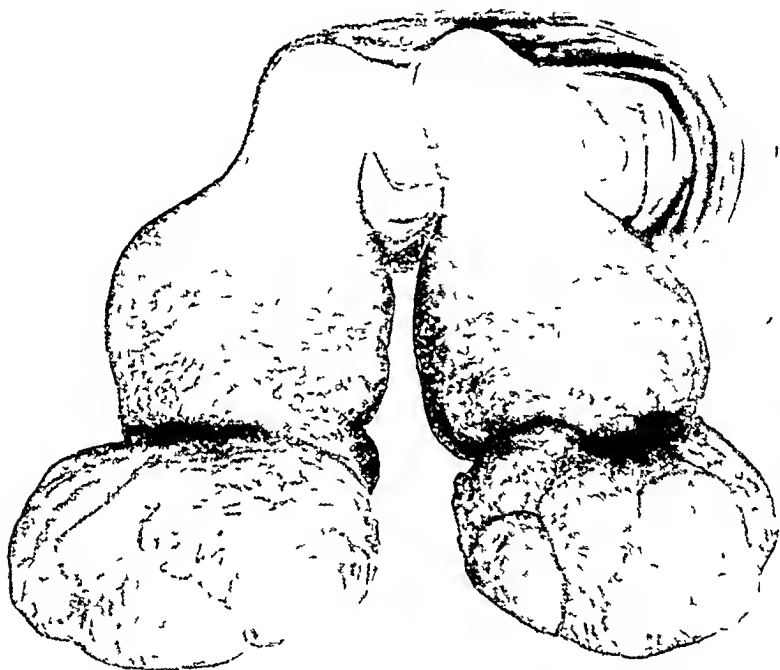


FIG 101 —NON FILARIAL ELEPHANTIASIS OF BOTH LEGS

From a woman who had never been out of England. The cause was not apparent, but had been in action many years.

also the skin, which becomes coarse and wart-like in appearance. (c) The warty stage is usually preceded by a development of vesicles (dilated lymphatics) in the papillæ, and from these when ruptured a considerable flow of lymph (*lymphorrhœa*) may follow. If sepsis supervenes, chronic ulceration and recurrent lymphangitis may follow.

The pseud-elephantiasis arising from chronic ulcers, or from disease of the lymphatic glands, can usually be dealt with by the pressure of an elastic bandage, but the limb is very likely to remain permanently enlarged, and in some cases where intractable ulceration and lymph fistulæ exist amputation is the best treatment.

**Elephantiasis Arabum** (*syn* Barbadoes leg) requires but little notice

here, as it is seldom seen in this country, being mainly limited to the tropics, especially the West Indies and South America. The legs, scrotum, and vulva are the parts most frequently attacked, but the face or breast may also be affected. It manifests itself as a hyperplasia of variable size of the subcutaneous tissues, whilst the skin becomes thickened and wart-like, and from it a copious discharge of lymph may escape. The parts sometimes attain enormous dimensions, the scrotum even reaching to the ground when the patient is



FIG 102 —NON-FILARIAL ELEPHANTIASIS OF SCROTUM, PENIS, AND THIGHS  
(FROM A PHOTOGRAPH)

The patient was a young man, and the cause of the trouble suppuration of the inguinal glands after scarlatina, the cicatrices of the incisions required in order to deal with the glands are plainly to be seen. The scrotum was much enlarged and very solid, the skin over it was covered with papilomatous growths, due to lymphatic dilatation. The skin of the penis was much thickened, and the subcutaneous tissues infiltrated. Over the thighs were scattered numbers of vesicles, which, when pricked, exuded lymph, and some of these were becoming transformed into solid fibrous growths. The legs and feet were also in a condition of solid œdema.

sitting. The disease persists for many years, and is not directly fatal.

The condition is due, as already mentioned, to the obstruction caused by the development of the *Filaria sanguinis hominis* in the lymphatics. These are spread (according to Manson) by the agency

of mosquitoes, in whose bodies the intermediate stage is passed. The dead mosquito, with its parasitic contents, falls upon the water, and in this way the ova find an entrance into the human stomach, where the young worm is set free, bores through the gastric mucous membrane, and finally becomes lodged in the lymphatics, especially those of the extremities. Not more than two or three pairs of mature filariæ are generally present in the same individual. The body of the female worm (which attains a length of 3 inches) is mainly occupied by the reproductive organs, and a countless number of embryonic filariæ are produced. Some remain coiled up in the lymphatic spaces, and give rise to the phenomena of lymphatic obstruction. Others become uncoiled, and are then about  $\frac{1}{16}$  inch in length, they find their way into the blood-stream, sometimes at night (*F. nocturna*), sometimes in the day (*F. diurna*), and can be readily seen under the microscope (p. 52). Manson claims that they are taken into the body of the mosquito with the blood which it abstracts, and thus a fresh generation is developed.

The **Treatment** is extremely unsatisfactory. Of course, if one can localize the situation of the parent filariæ, as has been possible in a few cases, they should be excised, but even then the lymphatic obstruction may persist. Mr. R. J. Godlee has treated several cases where the leg was affected by dissecting out the dilated lymphatics in the groin and implanting them into a tributary of the internal saphena vein, so as to relieve the limb of its engorgement with lymph, a process facilitated by elevation of the limb and the use of elastic bandages, the results have been encouraging. In other parts of the body one has to depend on less satisfactory measures. When the face or trunk is involved but little can be done. When the scrotum is affected, the morbid tissue can be freely dissected away, sufficient skin being left to cover in the wound if possible, the penis and testes must first be isolated, and then the scrotum amputated, a tourniquet being used to restrain the bleeding. Similarly, in very old-standing and aggravated cases of elephantiasis of the leg amputation may be the only resource.

### Affections of Lymphatic Glands

**Acute Lymphadenitis, or Inflammation of Lymphatic Glands**—The **Cause** of this condition is almost always the absorption of some irritative material (toxic or infective) from the periphery. When a part becomes inflamed, there is always an increased flow through the efferent lymph channels, owing to the exudation, the result of this is an increase in size of the glands to which the lymph is carried, which quickly subsides when the inflammatory process is at an end. If, however, irritating toxins are produced in the inflamed area, they give rise to a more prolonged and serious affection, whether accompanied or not by a similar condition of the lymphatic vessels. When pyogenic organisms are also absorbed, suppuration almost invariably results. In fact, the lymphatic glands must be looked on as the filters by means of which Nature eliminates many sources of disease.

It is curious that certain peripheral infective conditions are not at all liable to produce enlargement of the glands, *e.g.*, spreading gangrene and many forms of cellulitis, possibly the acuteness of the process causes lymphatic thrombosis in the efferent trunks, and thus hinders the absorption of the noxious material

**Pathologically**, the condition is characterized by hyperæmia of, and exudation into, the gland, which becomes redder, firmer, and larger than usual. Suppuration usually starts in more than one spot. A certain amount of peri-adenitis, or inflammation of the surrounding tissues, is always associated with it, even in the early stages, the latter may be of little importance, but when the capsule has given way it may become so extensive as to constitute a diffuse suppurative cellulitis.

**Clinically**, the glands can be felt as enlarged, tender, and rounded masses, the skin over them being red and œdematous, when pus has formed, the swelling, which is at first hard and brawny, becomes soft and fluctuating. They early contract adhesions to neighbouring tissues, and suppuration may extend widely beyond the glands, especially where there is much loose areolar tissue, as in the axilla. Fever, malaise, and all the general phenomena associated with an acute inflammation, are usually well marked.

The **Treatment** consists, in the first place, in the removal of all sources of irritation, both physical and physiological. The part must be kept at rest and protected from injury, and the offending wound or causative lesion dealt with by such antiseptic measures as may be needed to hasten its restoration to a healthy state. Fomentations or poultices are applied over the gland, and the patient, after the administration of a purge, may be given quinine and iron, if necessary. As soon as pus has formed, it should be let out by an incision, and the wound dressed antiseptically.

### Special Forms of Acute Lymphadenitis

The **Axillary Glands** are usually affected as a result of poisoned wounds of the hand or fingers, although other glands exist lower down in the arm, *viz.*, the supracondylar, just above the internal condyle. Boils in the axilla and excoriations or septic wounds of the breast may also cause an axillary abscess. In this region a suppurative peri-adenitis is often superadded, extending widely under and between the pectoral muscles, reaching even up to the clavicle. Care must be taken in opening such an abscess to avoid the main vessels by cutting from above downwards, midway between the anterior and posterior axillary folds, whilst Hilton's method should be adopted in all cases where the pus is situated deeply.

In the **Groin** there are three groups of glands. (1) The oblique set, running parallel to Poupart's ligament, and becoming inflamed in affections of the penis, scrotum, perineum, anus, buttock, and lower part of the abdomen, (2) a superficial vertical set, running with the long saphenous vein, and receiving lymph from all the superficial parts of the limb, except perhaps those from which the blood is returned by the external saphenous vein, the popliteal glands receiving the lymph from this region, and (3) the deep vertical set, receiving the deep lymphatics of the limb. Abscess in the groin is opened by a vertical incision, so as to allow the wound to gape when the patient sits, and prevent pocketing of matter.



Suppuration in the glands of the Neck is exceedingly common, arising most often from affections of the scalp (eczema or pediculosis), ear (otorrhœa or eczema), throat, or lips. As to the exact distribution of the lymphatics, we must refer students to anatomical textbooks. When opening a cervical abscess, care must be taken to avoid important structures, such as the external jugular vein, and to make incisions across the fibres of the platysma in order to gain space for efficient drainage.

**Chronic Lymphadenitis**—Three varieties of chronic inflammation of lymphatic glands are met with, viz., the simple, syphilitic, and tuberculous.

1 **Chronic Simple Lymphadenitis** is a condition resulting from some peripheral irritation, which is insufficient to cause an acute attack. It also occasionally results from blows and strains, as in over-walking, being in such cases possibly due to obstruction to the lymphatic flow, owing to compression or rupture of the efferent vessels. The glands become enlarged, tender, and painful, but as a rule they do not become adherent to one another, or to adjacent structures, and show but little tendency to suppurate. This condition often precedes, and, indeed, may be looked on as a predisposing cause of, tuberculous lymphadenitis. The **Treatment** consists in keeping the part at rest, removing if possible all sources of local irritation, combined perhaps with the local application of iodine paint or friction with iodide of potassium or iodide of mercury ointment. The general health should also be attended to, especially in children predisposed to the development of tuberculous disease.

2 **Chronic Syphilitic Lymphadenitis**—The lymphatic glands are involved in several ways in the course of syphilitic disease. (a) The primary lesion is associated with the development of an indolent bubo in the nearest lymphatic glands, which become hard, somewhat like almonds or bullets beneath the skin. But little pain is noticed unless suppuration is taking place, this is never due to the syphilitic virus alone, but to the absorption of some septic matter from the primary lesion. There is usually much more enlargement of, and infiltration around, glands in extragenital chancres than in those occurring about the genital organs. (b) In the second stage, when general infection has occurred, the glands in many parts of the body are affected in the same indolent fashion. (c) In the tertiary period the lymphatic glands may undergo a true gummatous change, or become enlarged and tender owing to the absorption of septic material from a broken-down gumma. For further particulars and **Treatment**, see p 141.

3 **Chronic Tuberculous Lymphadenitis** occurs most commonly in children or young adults who have inherited a predisposition to the development of tuberculous disease, and more especially in those whose surroundings are unhealthy, and whose general condition is deteriorated by insufficient or bad food and want of fresh air. Some local focus of irritation is usually present in the form of pediculosis capitis, decayed teeth, chronic otorrhœa, adenoids, or eczema of the face. As a result of this, neighbouring glands become chronically inflamed, and, as Sir T. Burdon Sanderson says, 'the soil is thereby prepared for the seed'. The bacilli are conveyed to the gland by

the blood or lymph, gaining access through some breach of surface, or even perhaps through a healthy mucous membrane, or perhaps they may be derived from some deep focus of quiescent tubercle, say, in the bronchial or mediastinal glands, a situation in which tubercle is often unexpectedly found. Any lymphoid tissue in the body may become the seat of tuberculous disease, but the glands of the neck, especially the submaxillary and the concatenate, are much more commonly involved than any others. The axillary and inguinal glands are also not unfrequently affected, whilst tuberculous disease of those in the mesentery gives rise to the affection known as 'tabes mesenterica'.

The course of the case may be described under the following headings, although it must be remembered that the stages do not necessarily follow one another in exact sequence. (i) The earliest manifestation of the disease consists in a *fleshy enlargement* of the glands, which cannot at first be distinguished, either clinically or pathologically, from a simple chronic hyperplasia. The gland may be enlarged to many times its natural size, and on section looks pinkish in colour, and is of firm consistence. Microscopically, all that is noticed is a great increase in the lymphoid corpuscles, together with some overgrowth and thickening of the fibrous capsule and trabeculæ. When tuberculous infection has occurred, the characteristic nodules can be seen under the microscope, but there is at first no change in the naked-eye appearances. (ii) *Caseation* follows sooner or later, and since the tuberculous nodules are often disseminated widely through the gland, many caseating foci will be found. (iii) *Calcification* of the caseous detritus sometimes occurs in those cases which are tending to recovery. Such is accompanied by a fibroid thickening of the gland, resulting from overgrowth of the capsular and trabecular connective tissue. This change is most frequently observed in the mediastinal and mesenteric glands, and is not very uncommon in the neck. (iv) More frequently *suppuration* ensues, sometimes from a simple emulsification of the caseating material, sometimes from a superadded infection with pyogenic organisms. Foci of pus develop at various spots in the glandular parenchyma, and when once formed, these tend to amalgamate and cause the destruction of the rest of the glandular tissue, the fibrous trabeculæ remaining longest unaffected, so that finally the gland is represented by a single abscess cavity surrounded by a pyogenic membrane of the ordinary tuberculous type, in which traces of the capsule can be observed. Several of these abscesses may unite one with another, and thus a large multiloculated cavity, containing pus mixed with curdy débris, is formed. (v) A certain amount of *peri-adenitis* is almost always present, though not to any great extent in the early stages, when, however, suppuration has occurred, or if the glands are exposed to pressure or friction, they become adherent not only to neighbouring glands, but also to surrounding structures. In the more chronic cases the fibro-cicatricial tissue thus formed may be so extensive as to fix the mass firmly to the deeper parts, such as the main

vessels and nerves, rendering removal by enucleation dangerous and almost impracticable. Important vessels are occasionally eroded by an extension of the suppurative process, and this may lead to fatal hæmorrhage (vi) Sooner or later the abscess, if left to itself, bursts either at one or several spots, leaving ulcerated openings, through which is seen œdematous granulation tissue mixed with caseating material. The edges are undermined, thin, and purplish, and the granulations sometimes sufficiently prominent to protrude through the openings as fungating masses. A variable amount of pus escapes from these, and the condition may persist for many years if radical treatment is not undertaken (vii) Under suitable local and constitutional measures these sores may, and usually do, heal after a time, giving rise to a pulpy spongy *cicatrix*, which is often puckered and more or less keloidal, and may retain its vascularity for a much longer period than would a healthy scar. Lymphatic œdema in the region drained by the affected glands is sometimes observed as a late consequence of this affection.

The usual complications met with in the course of all tuberculous diseases may also manifest themselves (p 165)

The **Treatment** of tuberculous glands is palliative or radical

**Palliative Treatment** consists mainly in improving the general health by means of suitable diet and tonics, such as cod-liver-oil and syrup of the iodide of iron, together with residence in a healthy, bracing situation, especially at the seaside, as, for instance, at Margate. All sources of local irritation must be removed so as, if possible, to prevent infection with pyogenic organisms, and counter-irritants, such as iodine paint, are best avoided. *Rest* of the affected part should be enforced as much as possible, in some cases the application of splints to restrict movement is advisable.

**Radical Treatment** — Wherever practicable, glands evidently tuberculous should be completely removed by dissection, and even amongst the wealthy too much time should not be wasted in palliative measures, inasmuch as the longer the glands are left, the firmer will be the adhesions which they are likely to contract with surrounding tissues. In the later stages, so far may this process have gone that removal by dissection is hopeless. In such cases a free opening is made down to the diseased tissues, and as large a portion removed as possible, whilst the remaining deeper parts are scraped with a Volkmann's spoon. The wound can rarely be entirely closed, and must be packed with gauze soaked in an iodoform emulsion (10 per cent), and allowed to heal by granulation. In septic cases the same line of treatment must necessarily be adopted.

In the *neck* very extensive operations may have to be undertaken for the removal of tuberculous glands. The incision varies with the situation of the mass, but every effort must be made to minimize the deformity and scarring. In the upper part of the neck, when the glands lie in front of the sterno-mastoid, an almost transverse incision may be employed, or one following the creases of the skin and very similar to that for ligature of the lingual artery (Fig 103, B). In

the lower half of the neck an incision along the anterior or posterior border of the sterno mastoid (E) will often suffice, or if the glands extend backwards a transverse one just above the clavicle (A')

When enlarged glands are present both in front of and behind the sterno-mastoid, as well as beneath it, their removal is perhaps most satisfactorily accomplished by a method suggested by Halsted. The incision commences close to the tip of the mastoid process, and, passing forwards just behind the jaw, sweeps across the neck to the middle of the clavicle (Fig 103, A), a second incision runs transversely just above the clavicle (A'). The flaps thus marked out are dissected up so as to lay bare the sterno-mastoid and the enlarged glands. The deep dissection commences from below and behind. The supraclavicular triangle is first cleared, the omo-hyoid muscle being divided, but sutures are left on the ends for identification. The anterior end is drawn up, and serves to raise the sterno-mastoid, which is then divided obliquely (D) below the spinal accessory nerve (C)

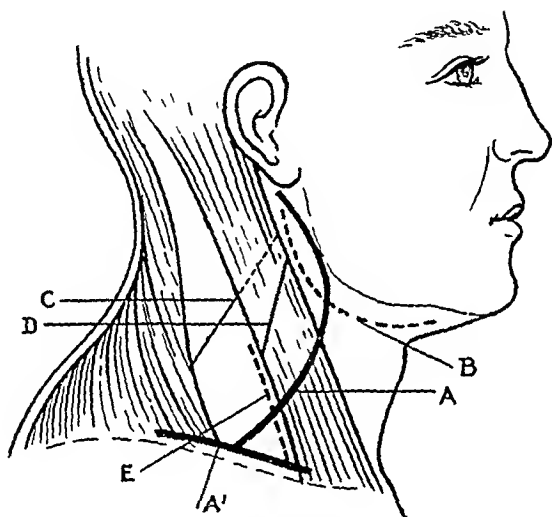


FIG 103 —INCISIONS FOR REMOVAL OF TUBERCULOUS GLANDS FROM THE NECK

A and A', For removal of glands from both triangles (Halsted's method), B, for removing glands from submaxillary and upper carotid regions, E, for removing glands in lower part of posterior triangle, C, spinal accessory nerve, D, site for division of sterno-mastoid

The divided ends are turned up and down so as to expose freely the glands lying on the carotid sheath, which are dealt with from below upwards. Special care must be taken of the nerves and of the internal jugular, but it is better to tie and remove this structure than to leave it in the wound with a number of lateral ligatures applied. During the vomiting that is almost certain to follow such an extensive dissection, lateral ligatures would very possibly be forced off by the suddenly increased intravenous tension thereby induced. When all the glands have been removed, the divided muscles are carefully replaced and sutured together, and divided fasciæ, etc, approximated by buried sutures. In this, as in all neck operations, the skin is brought together by Halsted's intradermic suture, and it is wonderful how little scarring and deformity follow this extensive procedure.

The *pre-auricular gland*, lying on the capsule of the parotid, is sometimes affected, and may cause facial paralysis, either as a result of the

sclerosing peri-adenitis, or from injudicious surgery. Any incisions made with a view to remove the gland or to open an abscess therein should be made in the direction of the fibres of the facial nerve, *i.e.*, horizontally.

In the *giron*, tuberculous glands are often mistaken for some condition due to venereal disease. The history of onset and the extreme chronicity should suffice to establish a diagnosis. The iliac glands will often be found similarly affected, and operations in this region are sometimes very extensive in consequence. Well-marked peri-adenitis is usually present in the iliac fossa, and the glands may be very adherent. Atrophy of the testicle sometimes follows, either from division of the spermatic vessels, or from their implication in the cicatrix.

### Tumours of Lymphatic Glands

The primary new growths occurring in lymphatic glands are **Lymph adenoma**, or Hodgkin's disease, **Lymphatic Leucocythæmia**, and **Lympho-sarcoma**. The subject has been greatly confused by the various names used by different writers, and by the fact that the same names have been used to denote very different conditions. Further, the structure of the growths in these three conditions is very similar, and their clinical histories have often a great resemblance, so that it is frequently a difficult matter to refer a given case to its proper group.

**Lymphadenoma**, Hodgkin's disease, or pseudo-leukæmia, is characterized by a progressive enlargement of the lymphatic glands and of the lymphoid tissue of the spleen, liver, and other organs. The affected glands and the masses in the viscera are quite characteristic in structure, and have a very different appearance from that seen in simple hyperplasia of the glands or in infective processes. The gland is homogeneous on section, the distinction between cortex and medulla being lost, and the whole of the gland being affected to the same extent, so that it is not possible, as in some malignant tumours, to distinguish between the actively growing and the older portions of the tumours. The lymphocytes are greatly reduced in numbers, so that the fibrous stroma of the gland becomes more obvious, if the latter is not very abundant the glands remain soft, but sometimes the stroma is much hypertrophied, and then the glands become hard. One type does not appear to pass into the other, and the soft form is, in most cases, more malignant and more rapid in growth than the hard.

Hodgkin's disease is most common in young adults, but no age is exempt, it is decidedly more common in males than in females. In some cases, as Trousseau pointed out, the cause of the first enlargement of glands is some inflammatory lesion, such as otitis media or dental caries, but usually no such origin can be traced. The glands first affected are usually superficial ones, and many become enlarged in one region before others are affected elsewhere, constituting a condition sometimes termed *benign or localized lymphadenoma*, the commonest group to be enlarged is the cervical, the axillary and inguinal being less often affected. In other cases the deep glands become enlarged

first, and this most commonly in the mediastinal group, the retro peritoneal glands coming next in order of frequency. When the disease is more advanced adenoid tissue in any part of the body may be affected. The spleen is usually somewhat enlarged, and in about half the cases presents localized grayish-white tumours (the *hard-bake spleen*). Similar growths may occur in the liver, kidneys, etc., or in the skin.

The early symptoms are slight, the only thing noticed being the glandular enlargement. In this stage the glands are isolated, and not adherent to the skin or to one another, they have little or no tendency to caseate or suppurate. There may be slight irregular pyrexia, or a continuous fever, but no blood changes.

When the internal glands are first affected, the earliest symptoms may be those of pressure. This is most marked in the mediastinal group of cases, in which the symptoms are those of aortic aneurism or thoracic tumour. In particular, pressure on the superior vena cava is noted, leading to engorgement of the superficial thoracic veins.

In the later stages the glands often fuse together, forming hard masses of large size, and the disease becomes generalized. The blood shows a moderate grade of anæmia of the secondary type, with a slight increase of leucocytes, especially of the lymphocytes. The fever is more marked, and there is often severe itching.

*Diagnosis* —(1) From *lymphatic leucocythæmia* (pp 51, 370) Hodgkin's disease is recognized by the entire absence of blood changes in the early stages, and by the presence merely of a secondary anæmia in the later. Moreover, lymphadenoma usually limits itself to regions in which adenoid tissue is normally present, leucocythæmia may develop new growths in any part of the body. (2) From *lymphosarcoma* it is known by the fact that it is almost invariably limited to the glands, and does not infiltrate surrounding tissues. Lymphosarcoma is characterized chiefly by its tendency to infiltrate, and also by producing secondary deposits in tissues which are not rich in adenoid tissue. (3) From *tuberculous disease* of glands the diagnosis is often difficult. Tubercle is more common in the very young, and is more frequently bilateral. The glands have a greater tendency to become united to one another and to suppurate, even when of small size. In doubtful cases microscopic examination of an excised gland may be required to settle the diagnosis.

The *Treatment* of Hodgkin's disease is unsatisfactory. Arsenic in increasing doses is of the greatest value, and the glands should be excised whenever accessible, repeated and extensive operations being sometimes required.

**Lymphatic Leucocythæmia** is of little surgical interest except in so far as it simulates Hodgkin's disease. The symptoms in the two are practically identical, except that in the former there are marked blood changes, the leucocytes are vastly increased, reaching 150,000 or more per cubic millimetre, and there is a great preponderance of lymphocytes, which constitute from 90 to 99 per cent of all cells present. There is also anæmia, often of some severity (p 51). Arsenic is valuable, and operative treatment useless.

**Lympho-sarcoma**—This term has been used in very different senses by different writers, and is best restricted to tumours which have a structure approximating to that of adenoid tissue—*i.e.*, which consist of small round cells, resembling, if not identical with, ordinary lymphocytes. These cells are set in a reticulated stroma similar to that of the lymphatic glands, Peyer's patches, etc. These tumours approximate closely to the ordinary small round-celled sarcomata, the only point of difference being the better development of the stroma in the lympho-sarcomata. They are recognised microscopically by the fact that they invade and destroy the surrounding tissues, and by their structure, which resembles that of adenoid tissue, but is devoid of any distinction between cortex and medulla. In some cases they are very difficult to distinguish from chronic inflammatory material of granulomatous type.

Lympho-sarcoma may commence in any part of the body, but in the vast majority of cases it originates in pre-existing adenoid tissue, most commonly in the glands in the root of the neck, the tonsil, or the mediastinum. It may also affect the intestines (commencing probably in the Peyer's patches) or in the testis. When commencing in a region where its development can be followed, it is seen to form a rapidly-growing tumour, which is at first firm, elastic, and painless, later on, however, as it increases in size, it becomes tender, and may cause great pain from pressure on, or implication of, nerves. It early contracts adhesions to surrounding parts, and gives rise to secondary growths in neighbouring glands by direct transmission. The superjacent skin is at first unaltered in colour and texture, but as the tumour increases, it becomes congested and shiny, and contains a network of dilated veins. Finally, it is involved in the growth, and ulcerates, an occurrence usually followed by the sprouting up of a bleeding fungating mass, similar in character to that formed by any other rapidly-growing malignant tumour. Dissemination of the growth throughout the viscera follows, death resulting from exhaustion and cachexia.

The *Treatment* consists in the removal of the mass, where practicable, without delay. If, however, extensive adhesions exist, this becomes absolutely impossible.

**Secondary Growths in Lymphatic Glands** are a special feature of all cancerous tumours. In the sarcomata they are less common, but are always present in the case of melanotic sarcoma, lympho-sarcoma, and usually in sarcoma of the testis, tonsil, and thyroid. The special characteristics of these are noted elsewhere.

## CHAPTER XV

### AFFECTIONS OF NERVES

#### Injuries of Nerves

THE simplest and most common forms of injury to which nerves are liable are **Contusions** and **Strains**, causing a sensation of tingling, or pins and needles, which usually wears off in the course of a few hours. In severe cases variable degrees of loss of power and sensation may ensue, and in hysterical women more or less neuralgia. In patients suffering from gout, syphilis, or rheumatism, a chronic peripheral neuritis is readily induced, often of a somewhat intractable type, and this even develops in healthy individuals. **Treatment** consists in gentle friction with stimulating liniments.

**Rupture** of nerves without an external wound only occurs in connection with severe injuries, such as dislocations or fractures, and even then total division is rare, the sheath retaining its integrity, although the axis cylinders may have given way. Immediate paralysis and loss of sensation usually follow, and may persist for a time, although repair not unfrequently occurs, since the sheath remains intact. The doubt always existing as to the condition of the sheath regulates the **Treatment** which must be followed, viz., one of expectancy. Friction and electricity should be applied to the parts, and only when these have failed should operation be undertaken. Secondary nerve suture under these circumstances is not a very successful proceeding.

**Compression** of a nerve is usually due to the growth of tumours or aneurisms, or to some displacement of bones, as in fractures or dislocations, or, again, the nerve may be included in the callus formed in the repair of a fracture—*e.g.*, the musculo-spiral, owing to its proximity to the humerus—the symptoms not appearing till four or five weeks after the injury, or it may be met with in the form of crutch palsy, or as a result of splint pressure, as when the external popliteal nerve is compressed against the neck of the fibula. Those nerves also which traverse bony canals in the skull are liable to pressure as a result of chronic osteitis and condensation of the surrounding osseous tissues. Patients who have suffered from syphilis are more liable to develop chronic neuritis from slight pressure than other individuals. The early symptoms are those of



irritation, *e g*, cramp and spasm of muscles or neuralgic pain, whilst the later ones, due to more prolonged compression, are those of paralysis and anæsthesia, combined sometimes with trophic phenomena. If the compressing cause can be removed, recovery, at any rate of a partial character, follows in time under suitable treatment, such as massage, electricity, and the administration of iodide of potassium or nerve tonics.

**Total Division of a Nerve**—The **Immediate Effects** are (a) Paralysis of the muscles supplied by the nerve, (b) complete anæsthesia of the parts supplied by it, which, however, is not necessarily permanent, since sensation may be conveyed by collateral trunks, the anæsthetic area passing through gradual stages of partial sensation before recovery is complete. (c) Vasomotor paralysis is also produced, the limb becoming hyperæmic and warmer for a few days, and then subsequently colder and insufficiently supplied with blood. (d) The excito-secretory nerves are paralyzed so that glands lose their functions for a time.

The **Secondary Effects** vary with the character of the nerve injured, and are much more complicated than the former. We must discuss them under five headings.

1. **Changes in the Nerve**—*Locally*, the two ends retract very slightly, perhaps not more than the twelfth of an inch, and the space thus formed fills with blood, which is quickly absorbed and replaced by granulation tissue, and this in turn by a bulb-like mass of fibro-cicatricial tissue (*traumatic neuroma*), within which are found spaces filled with fine nervous fibrillæ coiled up in loops and developed from the 'neurilemma cells, which, taking on an active neuroblastic function, secrete short lengths of axis cylinders and of medullary sheaths, and these, linking themselves together into chains, form continuous axis cylinders and medullary sheaths'\* After an amputation, most of the divided nerves are found to have developed these typical bulbous ends (Fig 104), whilst in nerves accidentally severed in their continuity the bulbous mass which forms on the upper end is separated by an interval from the atrophied lower end, though there is usually a fibrous connection between the two. These bulbs are often the seat of severe neuralgia. In a few rare instances immediate union of a divided nerve is supposed to have occurred, as indicated by total and rapid restoration of function, but it is quite possible that the phenomena in question were due to a transmission of nervous stimuli by collateral nerve-trunks.

*Peripherally*, an almost immediate invasion of leucocytes occurs as the result of the traumatism, and these are followed and replaced after a few days by proliferated connective-tissue cells. The so called Wallerian degeneration commences about the fourth day after the accident, in consequence of the separation of the nerve from its trophic centres. It first shows itself in the medullary substance, which undergoes a kind of segmentation, becoming broken up into

\* See Ballance and Purves Stewart, 'The Healing of Nerves' Macmillan and Co, 1901

irregular masses of myeline, which are absorbed by the connective-tissue cells, and disappear entirely in about a month. The axis cylinders also degenerate and disappear, being lost in the myeline masses. The neurilemma cells proliferate in columns and form a fibro-cellular mass, which represents the nerve, and has long lost all power of conducting nervous or electric stimuli, although attempts at regeneration are made at both ends.

*Proximally*, degeneration of the medullary sheath occurs, similar to that which is seen in the distal portion, but only extending as far as the next node of Ranvier. It is of but little significance.

2 **Changes in the Muscles**—Complete paralysis of motion necessarily occurs when a motor nerve has been divided, and the muscles involved slowly atrophy and undergo degeneration. The atrophy is not noticed at first, and is not so rapid as that arising from infantile palsy, since it is simply due to separation from the trophic centres, and not to their destruction. As a result of the paralysis and atrophy, deformity may ensue, owing to a disturbance of the equilibrium normally maintained between opposing groups of muscles. The *electrical* changes, too, are

exceedingly important. The faradic current rapidly loses its power over the affected muscles, and its effects totally disappear in two or three weeks, whilst the galvanic excitability remains for weeks or months, and even then only slowly diminishes, so that a condition develops in which the galvanic current produces a much greater contraction than the faradic (*reaction of degeneration*). As long as this phenomenon remains, there is a hope that restoration of the continuity of the nerve may be followed by restoration of function, but when the muscles react neither to galvanic nor to faradic stimuli, the case may be looked upon as beyond repair.

3 Various modifications of **Sensation**, both special, general, and muscular, may be observed.

4 The blood-supply to a paralyzed part is always diminished, so that it looks blue and congested, owing to the weak circulation, consequently, the temperature falls and the vitality of the part is decreased. This, associated with anæsthesia and the loss of trophic influence of the nerve centres, results in certain conditions which may be of considerable importance. Thus, the skin becomes thin, atrophic, bluish-red, and shiny ('glossy skin' of Weir-Mitchell), or it may be rough and covered with scales, or even œdematous. Chilblains are readily produced, and any exposure to cold or heat may result in vesication.

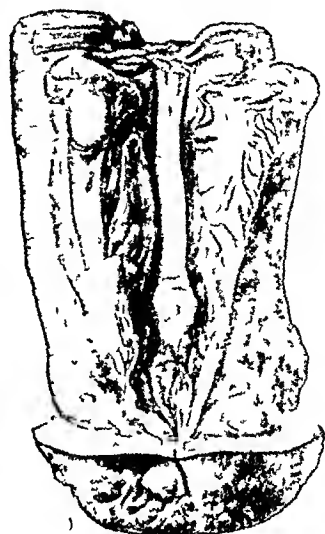


FIG 104.—TRAUMATIC NELPOMA OF POSTERIOR TIBIAL NERVE AFTER AMPUTATION OF LEG (FROM KING'S COLLEGE HOSPITAL MUSEUM)

or even sloughing. Wounds heal badly, and ulceration from slight irritants is very likely to occur, *e.g.*, corneal ulceration after division of the fifth nerve, and perforating ulcers of the foot. The cutaneous appendages are also involved, the hairs falling out, the nails becoming rough, brittle, and scaly, and the sebaceous and sweat glands either discharging an abundant secretion, or remaining absolutely functionless. Atrophy of the smaller bones may follow, and ankylosis of the terminal joints of the fingers or toes. In a growing child the development of the part is always more or less impaired. The more exaggerated forms of trophic trouble just described only occur in irritative lesions of nerves, *e.g.*, when a foreign body is left in contact with them, simple section results merely in simple atrophy.

5. Finally, in a few cases changes have developed in the central nervous system which are of extreme interest. In the early stages reflex spasms or paralyses are sometimes met with as temporary phenomena, but at a later date more serious symptoms may result. Thus, in a glass wound of the median nerve, a healthy man treated at hospital developed a typical epileptic fit whenever the neuralgic bulbous end was touched. The bulb was excised, and the nerve cleanly sutured, but without effect, the epilepsy and pain still remaining. The median nerve was divided in the upper arm, and a portion removed, but without benefit. Finally, the patient passed into a condition of chronic dementia, and died, no obvious lesions being found on post mortem examination.

**Regeneration** of a divided nerve must necessarily ensue if restoration of function is obtained. Attempts at regeneration are always evident in the distal segment, whether or not it has been sutured to the upper end, but in the latter case the phenomena are later in appearance and are never carried to perfection, owing to the intervention of the end bulb. Considerable discussion has arisen as to whether the new axis cylinders grow downwards from the central end to the peripheral, or whether they are developed in the distal segment. The researches of Ballance and Purves Stewart certainly favour the latter theory. The proliferated neurilemma cells always retain their longitudinal direction, and about three or four weeks after the operation (a little later, if no operation) thin beaded threads begin to show themselves along one side of such a spindle-shaped cell, and, gradually growing downwards, stretch out towards their nearest neighbours. The union of these small segments constitutes the new axis cylinder, which is gradually covered in by a medullary sheath, also apparently the product of the neurilemma cells, and finally joins with the central end of the nerve. The process takes some months to reach completion. Clinically, the earliest evidence of regeneration is a slight return of sensation, which may be at first abnormal, and only slowly becomes of a normal type. Motion is generally much later in its restoration than sensation, and may never be entirely recovered. Under very favourable circumstances it is possible for an interval even as great as  $1\frac{1}{2}$  inches to be bridged over by this process, but such an event is very unusual. The use of a nerve-graft under these conditions may direct the energies of

the neuroblastic cells, but the graft is itself quite passive, being invaded by neurilemma cells from above and below

The **Treatment** of a divided nerve depends upon its size and function. If small and of slight importance, no special treatment is required, but in any of the main nerves of the extremities it is essential to deal with them at once by **Primary Nerve Suture**. This is best accomplished by using a domestic sewing needle without cutting edges, or a fine Hagedorn needle, and the finest chromicized catgut, one or more stitches should pass through the nerve, and the rest merely through the sheath. Absolute asepsis is essential in order to obtain satisfactory results.

If the wound has been inflicted months before, and a bulb has formed, **Secondary Nerve Suture** must be employed. The nerve is first exposed by a free incision through the cicatrix, the two ends identified and isolated, and the fibrous tissue of the bulb removed to a sufficient extent to expose healthy nerve fibrillæ, the divided ends are then brought together with as little tension as possible. To fill up the gap resulting from removal of the bulb, traction upon each end of the nerve should be employed to stretch it, and the limb subsequently put up in such a position as to relax the parts, *e.g.*, the wrist flexed to a right angle, or the elbow bent (except when dealing with the ulnar nerve above the elbow, flexion of which increases the tension of the nerve). In one case we removed an inch or two of the humerus to allow the divided ends of the musculo-spiral nerve to be approximated. In order to diminish the drag on the fine end-to-end sutures, a tension stitch should be passed through the substance of the nerve, about  $\frac{1}{4}$  to  $\frac{1}{2}$  an inch from the divided ends.

*Nerve-grafting*, in order to bridge over a defect, has not up to the present been found of much practical value, although a few cases of success are reported. A nerve similar in size to that to be operated on is removed from an animal just previously killed, and carefully stitched in position. Since it merely acts as a carrier to the neuroblastic cells, the same result would possibly be obtained by passing several fine strands of catgut from one end to the other.

*Nerve anastomosis* has been utilized in a few cases of facial paralysis and in a few other instances in order to restore movement. A suitably placed motor nerve is united to the trunk of the affected nerve, and in time motor phenomena have manifested themselves with some degree of benefit.

During the time that the paralysis continues the limb itself must be well massaged, the fingers or toes worked daily to keep them from getting stiff, and the muscles treated with electricity, and preferably by means of the electric bath, one electrode being placed in a basin of warm saline solution, and the other against the patient's back, and the affected limb then dipped in the water till it becomes of a bright-red colour.

In many cases where the original wound has been complicated with spreading septic inflammation the impaired mobility is as much due to the inflammatory adhesions of joints and tendons as to paralysis.

### Inflammation of Nerves

**Acute Neuritis** is not a very common condition. It is usually due to injury, gout, or rheumatism, but is occasionally observed in connection with septic wounds. The nerve may sometimes be felt to be swollen or tender, whilst severe pain of a neuralgic type is often complained of by the patient. On microscopic examination the ordinary signs of inflammation are well marked, though mainly evident in the sheath. The **Treatment** consists of rest to the limb, together with leeching or dry cupping over the course of the nerve, combined with belladonna fomentations and suitable general therapeutic measures.

**Chronic Neuritis**, or **Perineuritis**, is much more common than the former. It consists pathologically in an increase of all the connective tissue of a nerve, both around it and between the fasciculi, with compression of the vessels and nerve-fibres. It may result from injury, such as sprains, strains, or pressure, especially when the patient is suffering from syphilis, rheumatism, or gout, and is met with after influenza and in various toxic conditions, *e.g.*, alcoholism, diabetes, malaria, etc. It is very common in the fifth nerve, and in the branches of the brachial plexus. The **Symptoms** vary a good deal with the nerve affected. Occasionally it can be felt thickened and tender on pressure, whilst more or less severe neuralgia is also noticed, accompanied, perhaps, by some loss of power in the muscles supplied by it. Trophic lesions may also be induced, such as perforating ulcer, or ankylosis of the terminal joints of fingers or toes.

The **Treatment** in the early stages consists in the administration of antidiathetic remedies, and, indeed, iodide of potassium, with or without mercury, is generally applicable. Locally, prolonged rest is needed, with counter-irritation in the form of blisters, and later on massage with suitable liniments. If there is any paresis, the muscles must be stimulated daily by the faradic current or electric bath. Excessive pain is combated by administering hypodermically morphia or atropine. Failing these, other means should be adopted, such as acupuncture, in which needles are passed into the substance of the nerve, and allowed to remain for a few moments, this probably acts by relieving the tension and inflammatory exudation within the sheath. Various operative measures dealt with under neuralgia may be called for in severe and protracted cases.

For **Tumours** of nerves, see p. 195

### Neuralgia

Neuralgia is a condition which either the physician or the surgeon may be called upon to treat, it is exceedingly common, and may be one of the most terrible afflictions to which the human frame is subject. It is characterized by a paroxysmal or intermittent pain of a darting or stabbing type, which follows the course of some particular nerve or nerves, especially the trigeminal. In this nerve the attack com-

mences suddenly, and the pain steadily increases until it reaches a climax, and then gradually or rapidly subsides. These paroxysms may last minutes or hours, and may recur at varying intervals, either a few in a day or many in an hour, they may be induced by sudden noises, a draught of air, etc. Moreover, pressure over the affected trunks may originate, relieve, or increase the pain, whilst the skin affected by them is often intensely tender, and even hyperæmic and œdematous (the *points douloureux* of Valleix). Occasionally adjacent muscles become spasmodically and sympathetically contracted during the attack, whilst excessive secretion, such as from the lachrymal or sweat glands, is also induced. Herpes is sometimes met with in the area of distribution of the affected nerve (*e g*, shingles in connection with intercostal neuralgia). Neuralgic manifestations may occur in any sensory or mixed nerve, such as the intercostals or sciatic, or in complex bodies, such as the breast, testis, or the larger joints.

The Causes of neuralgia are very diverse, and the surgeon often has to look far afield in order to find them. Thus, as *predisposing* causes may be mentioned the hysterical temperament, anæmia, and depressing circumstances of all kinds, especially mental anxiety and worry. The *direct* causes may be toxic, *e g*, malaria, influenza, lead, or mercury, reflex, *e g*, ovarian disease, worms, etc., central, from disease of the spinal cord or brain, radical, from pressure on the nerve-roots as they emerge from the spinal canal or cranium, or peripheral, owing to lesions of the trunks induced either by trauma, inflammation, or new growths.

**Treatment** consists primarily in attention to the general health, and the local application of counter-irritants and sedatives. Iron and arsenic may be given to anæmic patients, anti-spasmodics, such as valerianate of zinc, to hysterical women, quinine or arsenic for malaria, whilst sea-bathing or change of air is often advisable. Iodide of potassium and mercury are beneficial in all cases due to syphilis. When the pain is excessive, morphia, even in large doses, may be required. Empirical remedies, such as antipyrine, phenacetin, menthol, and croton-chloral hydrate will sometimes do good.

When, however, medicinal agents fail, surgical measures are indicated in order to allay the patient's sufferings. The following are the more usual methods adopted.

1. In purely Sensory Nerves, such as the trigeminal, simple division or *neurotomy* has often been resorted to, but the relief gained is of a most temporary nature, since sensory nerves readily unite after division, and sensation is rapidly restored even when union is incomplete, probably by transmission through collateral branches, hence the operation has fallen into discredit. A more satisfactory proceeding is *neurectomy*, or the removal of a portion of the nerve trunk, which does temporary good even in cases due to central causes, probably by placing the centre in a condition of rest through the exclusion of afferent stimuli. As large a portion of the affected nerve should be removed as possible, and Thiersch suggested a plan of *nerve extraction* in which the trunk is laid bare at a suitable spot, and then grasped with forceps and twisted out.

Finally, if all such measures have failed, the roots of the nerves may be divided either within the skull or in the spinal canal, or the ganglia connected with their roots may be removed

2 **In a Mixed Nerve**, conveying motor as well as sensory stimuli, *nerve-stretching* has to be mainly relied upon. The trunk is laid bare, and traction exercised, both centrally and peripherally, by means of a blunt hook if the nerve is small, or of the finger placed under it if large. The clinical effect is to abolish the conductivity of the nerve for a time, either completely or partially, but since it is not divided, repair and restoration of function follow. The elasticity and extensibility of the nerves are considerable, and the force needed to cause their rupture has been accurately estimated. It varies much in different individuals, and allowance must be made for this in all operations. Thus, the sciatic nerve will stand about as much traction as an ordinary man can make with his finger and thumb, it should be applied steadily and continuously, not in a series of jerks. The effect of stretching is to free the nerve from external inflammatory adhesions, and to alter the relations between the sheath and its contents. The perineurium has its fibrillæ, which are naturally wavy, straightened out, thereby compressing the lymphatic spaces between the fibres, and possibly rupturing the *nervi nervorum*. The nerve becomes hyperæmic, and the medullary sheath of the tubules may be irregularly broken up.

### Affections of Special Nerves

**The Cranial Nerves**—The **Olfactory Nerve** may be involved in fractures extending across the cribriform plate of the ethmoid, or in severe cases of contusion of the anterior lobes of the brain without fracture, resulting in loss of smell (*anosmia*)

The **Optic Nerve** is sometimes ruptured in fractures of the base of the skull running into the optic foramen, leading to sudden irremediable blindness, or it may be compressed by effused blood or inflammatory exudation, either within or outside of its sheath, causing more or less complete loss of vision preceded by optic neuritis (*i.e.*, inflammation of the intra-ocular termination of the nerve, or papillitis), but if the hæmorrhage has not been very extensive, vision may be in measure restored. Orbital cellulitis not unfrequently causes pressure on the nerve, either immediately as a result of the inflammation, or subsequently by cicatricial contraction. Syphilitic disease of the sheath, or the formation of a gumma in its neighbourhood, or intra-orbital aneurisms or tumours, may likewise induce amblyopia from pressure on the trunk.

The **Third Nerve** (*motor oculi*) being entirely motor, paralytic symptoms are those to be looked for. They may arise from *central* causes, such as syphilitic or degenerative changes in the floor of the third ventricle, or from *peripheral* lesions, such as aneurisms, tumours, trauma, etc., either in the orbit, sphenoidal fissure, or base of the skull. The **Symptoms** of complete paralysis are as follows (a) Ptosis,

or drooping of the upper eyelid, from loss of power in the levator palpebræ superioris, (b) external strabismus, or squint, from paralysis of the inner, upper, or lower recti, the eye being also directed a little downwards from paralysis of the inferior oblique, (c) mydriasis, or dilatation of the pupil, from palsy of the iris, (d) loss of accommodation, from the ciliary muscle being paralyzed, and (e) some slight protrusion of the eyeball (exophthalmos), owing to most of its muscles being flaccid and relaxed. In consequence, however, of its close proximity to the fourth, fifth, and sixth nerves in the walls of the cavernous sinus and sphenoidal fissure, symptoms referable to these trunks are often associated with the above, as also venous congestion of the eye and orbit from pressure on the sinus. Should the eyeball be totally immobilized from paralysis of all its muscles without venous congestion, the condition is known as ophthalmoplegia externa, and is always due to central disease affecting the floor of the third ventricle, and probably of syphilitic or tabetic origin. The **Treatment** in most cases consists in the administration of mercury and iodide of potassium.

Paralysis of the **Fourth Nerve (Pathetic)**, which supplies the superior oblique muscle, results in defective movement of the eyeball downwards and outwards.

The **Fifth or Trigeminal Nerve** is occasionally torn in head injuries, giving rise to anæsthesia, with perhaps ulceration of the cornea, but such cases are exceedingly rare. Much more common is the disease known as *trigeminal neuralgia*, or tic douloureux, which is more frequently observed in women than in men. It is to be clearly distinguished from the simpler forms of neuralgia due to some local irritation or general weakness by the paroxysmal character and violence of the pain, hence the term 'epileptiform tic' has been applied to it, and not inaptly represents the terrible nature of the affection. As a rule, it commences in the infra-orbital or inferior dental branches, radiating thence to all the other divisions of the nerve. The paroxysms are not very frequent at first, but they rapidly increase both in number and severity, until at last the patient becomes utterly prostrate, and either becomes a morphia habitué, or may even attempt suicide. The condition is often influenced considerably by the general health, and intermissions of varying length occur. The attacks are accompanied by twitching of the muscles of the face, and even of the neck, also by unilateral sweating and hyperæmia of the head, and the development of such marked 'points douloureux,' that possibly the patient cannot brush his hair or wash his face on the affected side, which becomes dirty and is often shiny from trophic changes. Lachrymation is a marked feature during the attacks, and there may be a considerable increase in the salivary secretion, as also in that of nasal mucus.

The **Cause** of the neuralgia is unknown, in a few cases tumours of an endotheliomatous character have been found involving the ganglion, but in the great majority nothing abnormal can be found either in the ganglion or its branches.

In the **Treatment** of epileptiform tic innumerable remedies have



been used, but the relief, if any, has been transient. Morphina is the only agent which can be relied on, and the large and increasing doses required do so much physical and mental harm as to render its use quite unjustifiable, except as a temporary expedient. Of course, all sources of reflex irritation should be relieved or treated, such as carious teeth, errors of refraction, intranasal trouble, ovaritis, etc. If the pain persists, **Operative Measures** will sooner or later be required. Neurotomy and nerve-stretching can only give temporary relief, and excision even of large portions of the nerve-trunks is very frequently followed by recurrence. The only procedure that holds out any certain hope of cure is removal of the Gasserian ganglion, or, at any rate, of its lower half, the facts that the first division of the nerve is rarely involved in trigeminal tic, that the nutrition of the eyeball is largely dependent on the maintenance of its nerve-supply, and that the upper part of the ganglion is intimately adherent to the outer wall of the cavernous sinus, have determined the practice of leaving the ophthalmic portion of the ganglion intact in the majority of cases. The results of this operation have been very gratifying, and have improved with increased practice and modern methods. At the same time it must not be looked on as devoid of operative dangers or risks, and hence, if the neuralgia is definitely limited to one division only, an extracranial neurectomy of an extensive character is advisable before attacking the ganglion, recurrence after such an operation, or the primary involvement of two divisions, indicates the major operation.

The *Supra-orbital Nerve* does not very commonly require division or extraction, since neuralgia of this trunk is usually distinct from epileptiform tic, and certainly more amenable to therapeutic measures. The pain often recurs about the same time each day, and may be treated by giving a pill containing ferri sulph., 1 grain, quininæ disulph., 2 grains, and morphinæ hydrochlor.,  $\frac{1}{2}$  grain, four hours before the attack is expected, and repeating it every hour till six pills in all have been taken. At the same time attention must be directed to any local cause of irritation. Should the pain persist in spite of treatment, neurectomy may be undertaken. The nerve emerges from the orbit through the supra-orbital notch, lying at the junction of the inner and middle thirds of the upper margin, it is reached by an incision following the course of the eyebrow, through which the orbicularis is divided along the line of its fibres (Fig 105, a). By incising the periosteum and depressing it, together with the orbital fat, the nerve can be followed back for some distance, and a considerable portion removed.

The *Infra-orbital Nerve* emerges from the foramen of the same name at a spot about  $\frac{1}{4}$  inch below the centre of the lower margin of the orbit. It can be reached and divided by a horizontal or curved incision placed over this site (Fig 105, c), but since such an operation is unlikely to give more than temporary relief, the root of the second division should be at once attacked if operative procedures are necessary. It is most desirable to divide the nerve behind Meckel's ganglion, and hence the operations which are performed from the face (either Wagner's, which follows the floor of the orbit, or Carnochan's, which traverses the antrum) are objectionable, whilst they are almost certain to leave ugly cicatrices (Fig 105, d).

The *pterygoid* method, or, as it is called, the Braun-Lossen operation, is without doubt the best for dealing with the root of the second division. Our experience of this proceeding, which is now extensive, has induced us to modify the original plans considerably, and our usual method of procedure is as follows. The incision commences at the external angular process of the frontal bone, follows

the upper border of the zygoma, and curves downwards in front of the ear to reach the angle of the lower jaw (Fig 90, B) The flap thus marked out, consisting only of skin and subcutaneous fat, is dissected forwards, temporarily fixed by a suture to the nose, and protected with gauze The zygoma is exposed by a horizontal incision through the periosteum, which is cleared from the bone by a suitable raspatory, and drilled front and back so as to carry silver wires in the subsequent suturing up (Fig 106), it is then sawn through and turned down, together with the masseter The mouth is slightly opened with a gag, and the temporal tendon pulled well backwards from the front of the temporal fossa by retractors, exposing thereby the pterygo-maxillary fissure, although the coronoid process is sometimes so large as to need partial or complete removal The internal maxillary vessels are then looked for, and, if possible, secured by ligation



FIG 105—*a*, Incision for division of supra-orbital nerve, *b*, line indicating position of supra-trochlear nerve, passing from angle of mouth through the inner canthus, the short cross-line at its upper end is the incision required to expose it, *c*, position of infra-orbital nerve and incision, *d*, Cruveilhier's incision for neurectomy of the second division

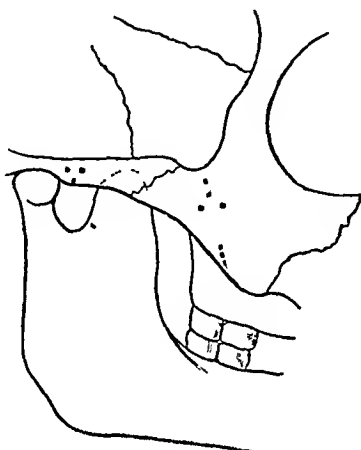


FIG 106—ZYGOMA AND LOWER JAW IN SITU TO SHOW POSITION OF SAW CUTS AND DRILL-HOLES IN THE BRAUN-LOSSON OPERATION AND IN THAT FOR REMOVAL OF THE GASSERIAN GANGLION

tures and divided The root of the second division of the fifth nerve can then be hooked up on an aneurism needle as it emerges from the foramen rotundum, and divided—a proceeding much facilitated by chiselling away a bony prominence which rises from the base of the great wing of the sphenoid, on the posterior aspect of the junction of the two limbs of the pterygo-maxillary fissure By also dividing the nerve as it emerges from the infra-orbital foramen through an incision in the face, the whole trunk is set free, and can be removed by traction, all the dental branches being torn across The displaced structures are then put back in position, the zygoma is sutured with silver wire, and the incision in the skin closed The results gained by this method have been very satisfactory, the scar being scarcely evident, and the movement of the jaw not impaired

In the *third division* trigeminal tic usually affects the lingual and inferior dental branches, and should be dealt with by dividing the trunk of the third division at the foramen ovale

The *Inferior Dental Nerve* is sometimes, however, the seat of neuralgia, due

to compression in its bony canal as a result of dental troubles. It may then suffice to trephine the inferior maxilla, making the necessary incision along its lower border, and remove half its thickness, so as to expose the nerve in its canal.

*Section of the third division of the fifth nerve at the foramen ovale* is best accomplished in the following manner. A flap of skin and subcutaneous tissue is reflected forwards from the parotid region, extending from the zygoma above to the angle of the jaw below (Fig 90, B), exposing thus the parotid gland with the socia parotidis and the masseter muscle, covered by fascia. If the incision is kept strictly to the subcutaneous tissues, the facial nerve is in no way endangered. The masseter is then divided transversely immediately below the socia parotidis, and the vertical ramus of the inferior maxilla cleared of muscle and periosteum to a sufficient extent to allow the application of a  $\frac{3}{4}$ -inch trephine just below the sigmoid notch, the remaining bridge of bone being subsequently removed by cutting pliers, enough bone is left in front and behind to preserve the continuity of the jaw with the articular and coronoid processes. The fibres of the external pterygoid muscle can now be seen crossing the upper part of the wound horizontally, and over it the internal maxillary artery sometimes courses, giving rise to considerable hæmorrhage if it is wounded. The lingual and dental nerves are usually found close together, emerging from under the outer pterygoid muscle, and lying between the internal pterygoid and the bone. The peripheral portions should be twisted or pulled up, and divided below as far down as possible, whilst by retracting the external pterygoid outwards, the foramen ovale can be seen, if electric illumination is employed, and the nerve-trunks divided at the point of exit. The wound usually heals well, and leaves but little scar, although some impairment in the mobility of the jaw may result from the cicatrization following disturbance of the muscles and tissues.

*Removal of the Gasserian ganglion* is now usually undertaken through the temporal region by some modification of what is known as the Hartley-Krause method. The pterygoid route originally followed in the pioneer operations by one of us (W. Rose) must be acknowledged to give insufficient exposure to ensure removal of the ganglion, and is now merely of historical interest.

The *Hartley-Krause operation* was devised independently by the two surgeons whose names are associated with it. An  $\Omega$ -shaped flap is marked out in the temporal region, the base situated just above the zygoma. Through this the subjacent bone is divided by chisel or electric saw, and the whole flap of skin, muscle, and bone is turned down *en bloc*, exposing the dura mater, which is gently stripped up from the middle fossa of the skull as far as the cavernous sinus. The middle meningeal artery is exposed and tied just above the foramen spinosum, or the foramen may be plugged with purified sponge or wax. Hæmorrhage from the small vessels, especially the veins, of the dura mater is sometimes profuse, but usually ceases upon gentle pressure. The dura mater and temporosphenoidal lobe of the brain are held up by one or two suitably-shaped spatulæ, and the second and third divisions of the nerve are seen running from their foramina to the ganglion. The dural sheath of the ganglion (cavum Meckelii) is opened, the ganglion itself detached from the bone, and as much of it as is thought necessary removed. The cavernous sinus may be wounded in this stage, or the dura itself give way and cerebro-spinal fluid escape. Removal of the spatulæ allows the brain to re-expand, the bone is then replaced, and the wound closed. The temporary compression of the brain seems to do no harm if the spatulæ are held with great gentleness, although temporary aphasic symptoms have been known to follow.

Various modifications of this procedure have been suggested. Many surgeons remove the bone from the temporal fossa completely with trephine and rongeur, and this certainly gives a better approach to the deeper parts. The subsequent defect in the cranium is covered in by the temporal muscle, and is of little importance. As to the extent of bone that is removed, practice varies. Some keep well above the infra-temporal crest and work rather from above—i.e., they simply take away the portion of bone turned down in the original Hartley-Krause method, others, notably Doyen,\* take away the bone from the floor of the middle fossa

\* For Doyen's operation, see *Practitioner*, May, 1902.

down to the foramen ovale, others, again, divide the zygoma at each end of the oval flap of skin and muscle turned down, and thereby gain a certain amount of room. Such modifications are of little real importance compared with the recognition of the principle that the ganglion can only be satisfactorily approached by lifting up the temporo-sphenoidal lobe and dura mater.

In all these operations special care must be taken of the eye as its nutrition is likely to suffer. The conjunctival sac should be washed out with warm sublimate solution (1 in 2,000), and the lids stitched together. These stitches are removed on the fourth or fifth day, and the conjunctiva washed with warm boracic lotion, but a pad should be kept over the eye for a fortnight.

The **Sixth Nerve** may be torn or compressed, either in its intracranial course along the inner wall of the cavernous sinus, or as it passes through the sphenoidal fissure, or in the orbit, as a result of penetrating wounds or blows. Its division causes paralysis of the external rectus and consequent internal strabismus.

The **Seventh or Facial Nerve** may be *paralyzed* from a great variety of causes, which may be described under the following headings.

(a) *Intracranial Lesions*—If simply *cortical*, as from pressure, hæmorrhage, degeneration, etc., a limited portion of the opposite side of the face is usually involved. If *subcortical*, or in the corona radiata or corpus striatum, as from hæmorrhage, or softening due to carotid thrombosis or embolus, the paralysis appears on the opposite side together with hemiplegia, but only the lower half of the face is palsied, the associated movements of the eyelids being left. If the lesion is situated in the *pons*, the deep facial centres may be implicated, and then paralysis with rapid atrophy of the facial muscles ensues on the same side as the lesion, together with loss of power of the opposite arm and leg (crossed paralysis). If the *root* of the nerve between the centres and the internal auditory meatus is involved, the whole of the same side of the face is paralyzed, accompanied, as a rule, by deafness.

(b) *Cranial Lesions*—There are two not uncommon causes grouped under this heading, viz., (1) fracture of the base of the skull, involving the petrous portion of the temporal bone, the paralysis supervening either immediately after the injury from laceration, a rare phenomenon, or some weeks later from implication in the callus, the usual cause, or (2) as a complication of chronic otorrhœa, and then due to compression or inflammation of the nerve in the aqueductus Fallopii. In both these forms the palsy is complete on the side affected, and owing to the communication of the facial with the petrosal nerves in this part of its course there may be unilateral drooping of the velum palati, the uvula being deflected towards the sound side.

(c) *Extracranial lesions* from injury, inflammation from exposure to cold, or the pressure of a tumour, *e.g.*, malignant disease of the parotid. This variety has been called 'Bell's palsy,' and is usually characterized by the whole side of the face being affected, but without implication of the palate or uvula.

The general **Signs** of facial paralysis (Fig. 107) are as follows. The side of the face is immobile and expressionless, all the natural folds and wrinkles being lost, the eye cannot be completely closed, and on attempting to do so the eyeball is usually seen to roll upwards and

outwards, ulceration, and even perforation, of the cornea may result from this exposure. From the drooping and relaxation of the lower eyelid, the apposition of the punctum lachrymale to the conjunctiva is imperfect, and thus tears escape over the face (epiphora), a condition aggravated by the loss of the suction-like action of the lachrymal sac, owing to the associated paralysis of the *tendo oculi* and *tensor tarsi*. On attempting to move the face, as in laughing or showing the teeth, the muscles on the non-paralyzed side are alone contracted, and marked asymmetry results from the drawing over of the opposite side. The lips cannot be closed firmly, and hence whistling and such-like actions are prevented. Food collects between the cheek and the teeth, owing

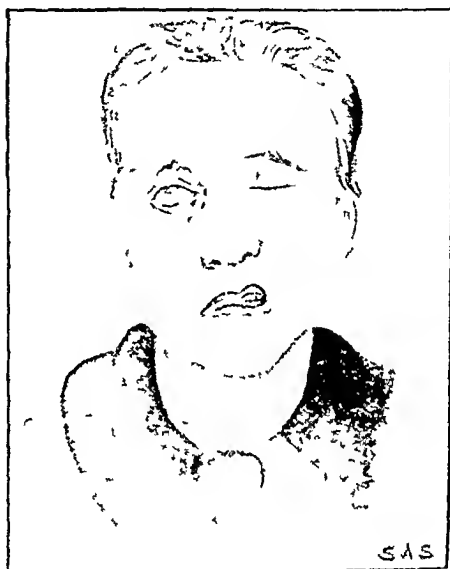
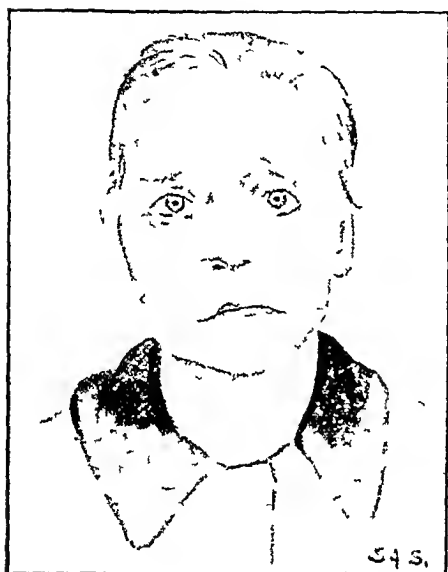


FIG 107 —FACIAL PARALYSIS (FROM PHOTOGRAPHS)

On the left side the face is in a position of rest, on the right side an attempt has been made to close the eyes, that on the paralyzed side remaining open, and the eyeball rolling upwards and outwards, whilst the asymmetry of the face becomes more manifest

to paralysis of the buccinator, and the patient after a meal has to clear out the débris with a spoon or his fingers

The **Treatment** of facial paralysis necessarily depends upon its cause. In the majority of cases medical treatment (including the administration of perchloride of mercury and iodide of potassium) will suffice, together with massage and electricity, in others, surgical measures with a view to remove some obvious cause of pressure may be necessary. Where, however, the paralysis cannot be dealt with in this way, *nerve anastomosis* may be undertaken, the whole or a portion of the spinal accessory nerve being united to the divided peripheral end of the facial nerve. The results hitherto obtained in a few cases have been encouraging, facial movements slowly returned, but at first were

always elicited by and accompanied with movements of the shoulder, in time, however, they became more independent, but were rarely quite free. However, the operation gave a certain amount of muscular play, and removed the facial asymmetry so characteristic of this lesion.

**Facial Tic** (or histrionic spasm) consists of a clonic contraction of the facial muscles, due to some lesion of the centre in the pons or cortex. The condition causes great discomfort to the patient, and may involve the whole side of the face, or merely one part of it, such as the orbicularis oculi. **Treatment** consists in the administration of nerve tonics or antispasmodics, and, failing that, *stretching*, or even in severe cases division, of the *facial nerve* has been employed, but is most unsatisfactory.

**Operation**—The facial nerve is exposed immediately below the ear, its position being indicated by a horizontal line drawn from the middle of the anterior border of the mastoid process, and usually corresponding to the point where the mastoid meets the lobule of the ear. The incision extends from just behind the external meatus along the anterior border of the sternomastoid muscle to the level of the angle of the jaw. The parotid gland is separated from the muscle, and both are well retracted, exposing by this means the posterior belly of the digastric. The facial nerve is found above this, running directly forwards from the centre of the mastoid process. The great auricular nerve is divided in the superficial incision, and the posterior auricular vessels will require a ligature. The internal jugular vein is close to the posterior margin of the wound. The operation is a deep one, and by no means easy in a patient with a thick neck. The *effect* of stretching the nerve is to paralyze it temporarily, but the ultimate results have been by no means encouraging, only one case out of twenty collected by Godlee being successful.

The **Auditory Nerve** may be injured in fractures of the base of the skull, either one or both sides being involved. Incurable deafness usually results, often associated with facial palsy.

It is a little doubtful what effect would be produced by injury of the **Glosso-pharyngeal Nerve**, but in one case in which it was supposed to be compressed the patient suffered from difficulty in swallowing and speaking, together with persistent ulceration of the tongue, death resulted from œdema of the glottis.

A severe injury to the **Pneumogastric Nerve** may prove rapidly fatal, but less serious lesions result in palpitation, vomiting, and a sense of suffocation, such phenomena sometimes manifest themselves after head injuries, especially fractures involving the posterior fossa, and indicate that the jugular foramen has been encroached on. The nerve is also exposed to injury in operations about the neck, *e g*, ligature of the carotid, or removal of tuberculous glands. Irritation causes vomiting and temporary inhibition of the heart's action, one-sided division sometimes does comparatively little harm, but if both nerves are divided, death results from laryngeal paralysis or from such complications as œdema or congestion of the lungs. When the vagus is injured in the lower part of the neck or compressed by an aneurism, or if the recurrent laryngeal nerve is divided or compressed, hoarseness or partial aphonia is produced, from paralysis either of all the muscles on one side of the larynx, or in slighter cases only of the abductor (crico arytenoideus posticus).

The **Spinal Accessory Nerve** may be irritated, either at its exit from

the skull by a fracture running through the jugular foramen, or in its peripheral course by inflamed lymphatic glands, etc. It is not unfrequently divided in operations for the removal of tuberculous glands, and may cause some temporary drooping of the shoulder. Clonic spasm of the sterno mastoid and trapezius is generally due to central changes, and it is for this form of spasmodic torticollis that *stretching or division of the spinal accessory nerve* is employed.

**Operation**—The nerve runs downwards and backwards at right angles to the centre of a line passing from the angle of the jaw to the apex of the mastoid process, it enters the deep aspect of the sterno-mastoid about 3 inches below that spot. An incision is made along the anterior border of the sterno-mastoid, reaching from the ear to the cornu of the hyoid bone. The fascia is divided, and the muscle drawn backwards to expose the posterior belly of the digastric, from under the lower border of which the nerve emerges, passing first in front and then below the transverse process of the atlas, which can be readily felt. The operation has not given good results, since, even if the twitching of the head and neck ceases, the spasmodic phenomena often recur elsewhere.

The **Hypoglossal Nerve** may be accidentally divided in an operation, or compressed by an aneurism of the external carotid, or by a new growth. Unilateral paralysis or weakness of the tongue results, the organ, when protruded, being directed towards the paralyzed side.

### The Spinal Nerves

The nerves constituting the **Cervical Plexus** are exposed to injury either from blows, dislocations of the cervical spine, penetrating wounds, or during operations. No very serious results follow, except in the case of the **Phrenic Nerve**, division of which may cause instant death by paralysis of the diaphragm, although when but one nerve is divided the patient can survive. Irritation of the nerve gives rise to spasmodic cough or hiccough.

The **Brachial Plexus** may be injured from exactly similar causes, paralysis or spasm of the muscles of the arm arising from division or irritation of the motor branches, whilst neuralgia, hyperæsthesia or anæsthesia, may follow from damage to the sensory trunks. Thus a blow on the back of the neck opposite the fifth or sixth vertebræ caused paralysis of the serratus magnus and rhomboids (winged scapula), an old unreduced unilateral dislocation of the seventh cervical vertebra produced intense neuralgia along the course of the ulnar nerve, and many similar instances might be mentioned.

One special form of injury may be alluded to in which the roots of the fifth and to a less extent of the sixth cervical nerves are wrenched or torn as a result of a fall on the shoulder, which is pressed downwards, whilst the head is forced over to the opposite side, a type of accident which is liable to follow a spill from a high dog-cart. The result is paralysis of Erb's pre-axial group of muscles, including the supraspinatus, infraspinatus, biceps, deltoid, and supinators, arising from the fifth nerve, whilst the extensors of the fingers and wrist are involved when the sixth nerve is also injured. Sensory lesions are usually slight, and recovery, though slow, ensues after a time. A

similar affection sometimes appears in infants as a birth paralysis (Duchenne), due to excessive lateral displacement of the head during delivery. The shoulder engages the brim of the pelvis, and is hindered in its onward passage, whilst the head is forced on.

The **Treatment** is mainly symptomatic, including the administration of iodide of potassium and the local application of blisters or other counter-irritants and of electricity. In cases where there is severe and intractable neuralgia, not referred to any discoverable lesion, or where clonic spasm of the muscles of the arm and shoulder are met with, *stretching of the brachial plexus* may be required. In several cases of Duchenne's birth paralysis operation has been undertaken to expose the injured fifth and sixth nerves, the cicatrix has been found and removed, and a good result has followed.

**Operation**—The patient lies on his back, with the head directed to the opposite side, and the arm well drawn down, a cushion is inserted under the shoulder to steady it. An incision is made above the centre of the clavicle, 3 or 4 inches in length, parallel to the anterior border of the trapezius. The platysma and deep fascia are divided, and the deep cellular tissue opened up by retracting the margins of the wound. The posterior belly of the omohyoid is thus exposed, and the posterior border of the scalenus anticus defined. The cords of the plexus are found emerging between the latter muscle and the medius, they are carefully isolated by division of the sheath covering them, and pulled upon by the finger or an aneurism needle passed under them. Special care must be taken of the lowest cord of the plexus, which passes behind the subclavian artery. The nerves are stretched both centripetally and centrifugally. Excellent results have followed this operation, although in a few cases the necessary cicatrization which followed led to a recurrence of the symptoms.

The **Circumflex Nerve** is liable to injury from its exposed position, winding round the outer side of the neck of the humerus about a finger's breadth above the middle of the deltoid. Blows upon the shoulder may in this way cause paralysis, it is sometimes torn or compressed in fractures of the surgical neck of the humerus, or in dislocation of the shoulder, or it may be impacted in the callus arising from the former injury. Paralysis of the deltoid and teres minor follows, evidenced by inability to raise the arm from the side, whilst the wasting of the former muscle causes undue prominence of the acromion. There may be temporary anæsthesia over the posterior fold of the axilla, but this does not last long. No operative treatment has been adopted, although we see no reason why it should not be attempted in suitable cases.

The **Musculo-Spiral Nerve** is not unfrequently damaged in fractures and dislocations of the upper extremity of the humerus, but is especially exposed to injury in the musculo-spiral groove, where it lies close to the bone. It is implicated with or without other nerves in crutch palsy, or by lying asleep with the arm across the edge of a chair or table, as so frequently occurs in drunken people (commonly called 'Saturday-night paralysis'). It is not unknown after operations when the outstretched arm has rested on the edge of the table, and is a disconcerting sequela that is easily preventable. It has also occurred after operations in the Trendelenburg position, where the arms have



been kept above the patient's head, the upper end of the humerus pressing against the brachial plexus, and causing symptoms not purely musculo-spiral in type. In this position the arms should not be elevated, but folded across the chest.

The **Symptoms** arising from its total division are as follows

- A Anæsthesia over the front and back of the outer side of the elbow and fore-arm (external cutaneous branches), over the radial side of the dorsal aspect of the wrist and hand, and over the back of the thumb, index, middle, and half of the ring fingers, to a variable extent (Fig 110, *ra*)
- B Paralysis of the following groups of muscles
  - (i) Of the extensor of the fore-arm (triceps), hence the fore arm can only be extended by its own weight
  - (ii) Of the long and short supinators, hence the hand is pronated, the only supinator remaining being the biceps

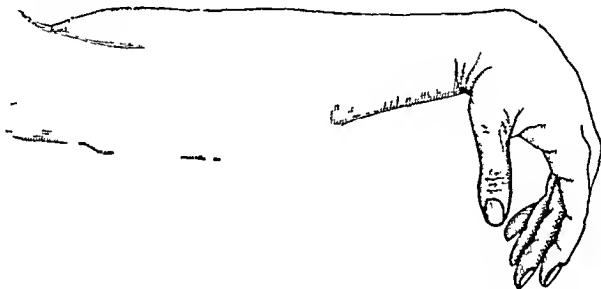


FIG 108 — WRIST-DROP FROM PARALYSIS OF THE MUSCULO SPIRAL NERVE (TILLMANN'S)

- (iii) Of the radial and ulnar extensors of the wrist, hence wrist-drop (Fig 108), a condition also present in certain lesions of toxic or central origin, *e g*, lead palsy and progressive muscular atrophy
- (iv) Of the extensors of the fingers and thumb, which either hang limp and motionless, or may be bent up into the palm from the unopposed action of the flexor muscles. If, however, the wrist and proximal phalanges are supported and extended, the terminal phalanges can be straightened by the action of the interossei and lumbricales.

**Treatment** consists in massage and electricity applied to the muscles, but in some cases an operation is necessary.

**Operation** — The nerve can be exposed on the outer side of the arm after it has traversed the external intermuscular septum, where it lies between the brachialis anticus and supinator longus. To define this intersection the fore-arm is semi flexed and pronated, and an incision made extending from the centre of the crease of the elbow upwards and outwards along a line made by prolonging upwards the radial border of the fore arm, which in this position corresponds with the supinator longus muscle. The interspace is opened up, and the nerve found together with the termination of the superior profunda artery. From this point the nerve may be traced upwards, if necessary, by dividing the intermuscular septum, and retracting or dividing the triceps.

To expose the upper part of the nerve as it enters the groove, the arm is placed over the body, and the posterior border of the deltoid defined. An oblique incision is made a finger's breadth behind this, and the intersection between the long and outer heads of the triceps found. By opening up this space the finger can be passed down to the bone, and the nerve, together with the superior profunda artery, readily exposed.

Where the nerve is impacted in the callus arising from a fracture of the middle of the shaft of the humerus, it is often best to expose it by a median incision down the back of the arm, splitting the triceps, the centre of the wound being opposite the insertion of the deltoid.

The **Median Nerve** may be damaged in fractures and dislocations of the humerus, but is most frequently injured just above the wrist by glass wounds, due either to bursting of bottles, etc., or to thrusting

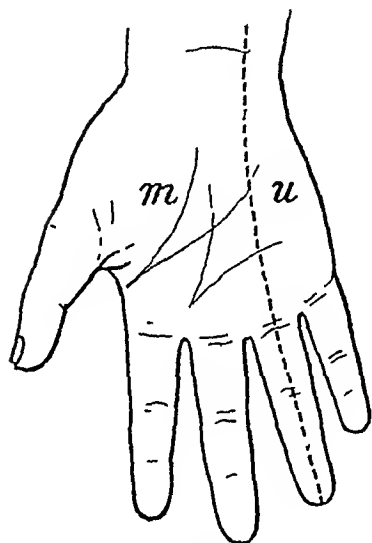


FIG 109

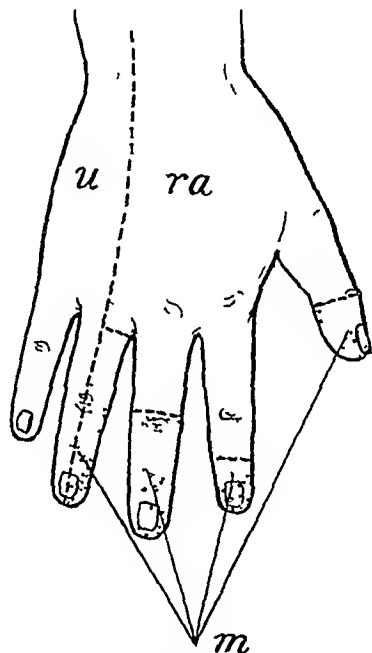


FIG 110

FIGS 109 AND 110 —DISTRIBUTION OF SENSORY NERVES OF HAND FROM FRONT AND BACK

*m*, Median nerve, *u*, ulnar, *ra*, radial

the hand and arm through a window. Paralysis necessarily results in these cases, with the following symptoms

*If divided just above the wrist*

- A Anæsthesia over the palmar aspect of the radial side of the hand, over the front of the thumb, index, middle, and half the ring fingers, and over varying portions of the dorsum of the same (Figs 109 and 110)
- B (1) Paralysis of the outer group of the short muscles of the thumb (*i.e.*, abductor, opponens, and outer half of the flexor brevis pollicis), so that the thenar eminence wastes,

and the movement of 'opposition' is impaired, the thumb remaining extended by the side of the fingers (Duchenne's 'ape hand')

- (ii) Paralysis of the outer two lumbrical muscles, causing loss of power of flexion at the metacarpo-phalangeal joints of the index and middle fingers

The great impairment of mobility in the hand and fingers so often seen in these cases depends not so much on paralysis of muscles as on the fact that in the majority of them the synovial sheaths of the wrist are also laid open and involved in septic inflammation, which leads to the formation of diffuse adhesions. Hence the prognosis is often unsatisfactory, even when the nerve has been skilfully sutured at a secondary operation

*If divided at the bend of the elbow or in the arm*, to the above-described symptoms are added

- (i) Loss of pronation from paralysis of the two pronators
- (ii) Paralysis of the flexor carpi radialis, causing defective wrist flexion on the radial side and impaired radial abduction
- (iii) Paralysis of the flexor longus pollicis, of the flexor sublimis, and the outer half of the flexor profundus digitorum, leading to loss of power in the hand-grasp, especially on the radial side, and perhaps hyper-extension of the wrist
- (iv) Paralysis of the palmaris longus

*Operations*—When the nerve has been divided, primary or secondary nerve suture should always be undertaken. In the latter case incisions are made through the old scars, which may be removed with advantage, the ends of the nerve clearly defined, and the bulb removed. Suture is often very difficult from lack of material, and to assist in the apposition of the segments the hand is flexed to a right angle, and also the elbow, and maintained in that position by a poro-plastic or plaster of Paris splint

In order to stretch the nerve, it may be exposed in the arm by an incision similar to that for ligature of the brachial artery, or at the wrist by an incision placed to the ulnar side of the flexor carpi radialis tendon, between that structure and the palmaris longus or flexor sublimis tendons

The **Ulnar Nerve** is exposed to injury at the wrist, as also in the hollow between the olecranon and the inner condyle of the humerus, and paralysis may be caused by wounds, fractures, blows, implication in callus, etc. The symptoms are very characteristic

*If divided at the elbow*

A Anæsthesia of the ulnar side of the front of the wrist and palm (palmar cutaneous branch), over the back of the hand, and of the little and half the ring fingers, back and front (Figs 109 and 110)

B (i) Paralysis of the flexor carpi ulnaris, causing weakness in flexion and in ulnar adduction of the wrist

(ii) Paralysis of the inner half of the flexor profundus, with weakened hand-grasp, especially in the ring and little fingers

(iii) Paralysis of the two inner lumbricales and of all the inter-ossei, hence, loss of adduction and abduction of the fingers, with flexion of the two last phalanges in each finger and

hyper-extension at the metacarpophalangeal joint (main-en-grieffe or claw hand, Fig 111) The interosseous spaces also become very evident from atrophy of these muscles

- (iv) Paralysis of the short muscles of the little finger, of the inner group of short thumb muscles (adductor transversus, adductor obliquus, and deep portion of flexor brevis), and of the palmaris brevis

*If divided just above the wrist*, the anæsthesia only involves the palmar aspect of the hand and back of the terminal phalanges, whilst the paralysis merely affects the short palmar muscles. Additional impairment of movement may, however, arise from septic inflammation of the long tendons and their sheaths

**Treatment**—If divided, the nerve must be dealt with (according to the rules already given) at the injured spot

To expose the nerve for the purpose of stretching for neuralgia, or suturing, the following methods may be adopted (a) In the upper arm an incision is made similar to that for tying the brachial artery, but half an inch behind it (b) At the elbow, cut down just behind the internal condyle, and find the nerve behind the internal intermuscular septum with the inferior profunda artery (c) Just above the wrist it lies to the radial side of the flexor carpi ulnaris between the tendon and the ulnar vessels, the skin and deep fascia alone need division

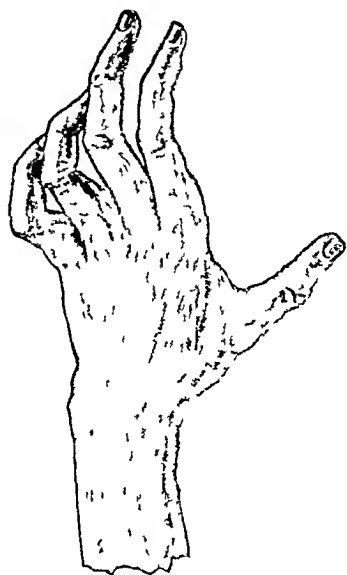


FIG 111—CLAW HAND (MAIN-EN-GRIFFE) FROM ULNAR PARALYSIS (AFTER BYROM BRAMWELL)

The **Intercostal Nerves** are frequently the seat of severe neuralgia, either from a chronic neuritis, probably of toxic origin, from compression by tumours or inflammatory lesions of the ribs, or from injury or pressure directed to the nerve-roots as they emerge from the spine. Herpes zoster or shingles is a very frequent sequela to such pain, and may be followed by some amount of anæsthesia

**Sciatica**, or neuralgia of the great sciatic nerve, is a most painful affection, and often exceedingly intractable. It may arise from the following **Causes** (a) Inflammation of the neurilemma (acute or chronic), the result of cold, injury, gout, rheumatism, syphilis, and many toxic agents, (b) pressure upon the extrapelvic portion of the nerve, as by aneurisms, tumours, or old-standing dislocations of the head of the femur on the dorsum ili, (c) similar pressure upon the nerve in the pelvis, or as it emerges through the sacro-sciatic notch, as from sarcoma or osteoma of the pelvic bones, rectal or uterine cancer, a pregnant uterus, or uterine fibroids, (d) pressure upon the nerve-roots in the spinal canal, as from caries or sarcoma, (e) chronic diseases of the spinal cord, such as tabes.

The **Symptoms** are very evident, the pain shooting down the back of the thigh and often referred to the toes. It is of a paroxysmal nature, and may be brought on by pressure over almost any part of the nerve or by movements of the thigh, and hence the patient's gait is stiff and shambling. Tenderness in the line of the nerve is felt when the cause is a peripheral neuritis, and the trunk may sometimes be detected on palpation as a thickened cord. The limb is often kept slightly bent, but complete flexion of the thigh on the pelvis is an impossibility, and if, when the patient is standing against a wall, the limb can be raised to a right angle with the knee extended, it is certain that sciatica is not present.

The **Treatment** necessarily varies with the cause. If due to neuritis or perineuritis, general anti-syphilitic or anti-rheumatic measures may be adopted, and blisters or sedative remedies in the more acute cases applied to the back of the thigh. Hypodermic injections of morphia and atropine may also be useful, but if all the usual anti-neuralgic remedies have been exhausted without benefit, stretching of the nerve may be employed.

*Stretching of the sciatic nerve* may be required for (i) neuralgia of an intractable type, (ii) paralysis or spasm of muscles supplied by it, owing to adhesions contracted between it and surrounding parts, the result of injury, cellulitis, or perineuritis, (iii) in paralysis or spasm due to some forms of tabes. The nerve may also be exposed in order to suture it after it has been divided. Nerve-stretching may be accomplished without operation by flexing the thigh upon the abdomen and then extending the knee, in cases of sciatica an anæsthetic will be required for this, but it may be attempted before undertaking further measures.

The nerve is best *exposed* for stretching at the point where it emerges from under cover of the gluteus maximus, midway between the tuber ischii and the great trochanter. The patient lies in the prone position with the limb slightly flexed, and a 4 or 5 inch incision is made vertically downwards from the gluteal fold in the middle line of the thigh. The lower border of the gluteus maximus is first exposed, and its fibres seen running downwards and outwards. The hamstring muscles emerging from under it are drawn inwards, and the nerve is found ensheathed in loose connective tissue, it is stretched, by a finger hooked under it, both peripherally and proximally.

The **Anterior Crural Nerve** may be paralyzed as a result of injury or pressure, and may be the seat of neuralgia or spasm. Its division causes paralysis of the quadriceps extensor, pectineus, and sartorius, and the most marked effect will be secondary flexion of the knee-joint from the unopposed action of the hamstrings, anæsthesia extends over the front of the thigh and along the inner side of the leg and foot as far as the ball of the great toe. The nerve may be exposed on the outer side of the femoral vessels, just below Poupart's ligament, by a vertical incision half an inch outside the line of the artery.

The **External Popliteal Nerve** may be divided during a subcutaneous tenotomy of the biceps, to which it lies immediately internal, or compressed, as it winds round the neck of the fibula, by strapping,

bandages, or splints, or it may be injured in fractures of the neck of the fibula. Total division causes anæsthesia over the dorsum of the foot, together with paralysis of the extensor and peroneal groups of muscles, and from the contraction of the unbalanced opposing groups, the paralytic form of talipes equino-varus results. The nerve may be exposed by making an incision  $1\frac{1}{2}$  inches long to the inner side of the biceps tendon, terminating at the neck of the fibula. The knee is then flexed, and the nerve is readily found embedded in the loose cellular tissue of the popliteal space.

The **Internal Popliteal Nerve** is much less exposed to injury owing to its more sheltered position. Division results in anæsthesia of the back of the calf and sole of the foot, and in paralysis of the calf muscles, flexors of the foot and toes, and of the short muscles of the sole. Paralytic talipes calcaneo-valgus is very likely to ensue. The nerve is laid bare by a vertical incision in the middle of the popliteal space, which should avoid the short saphena vein. After division of the deep fascia, the nerve is the most superficial structure.

If the **Tibial Nerves** are divided, the resulting effects are more limited, thus, paralysis of the extensors of the foot and paralytic talipes equinus result from division of the anterior tibial, and paralysis of the short and long flexors of the foot and of the interossei, with resulting talipes calcaneo-valgus, follow lesions of the posterior tibial. The nerves may be exposed in the same way as the accompanying arteries (p. 340).

The **Sympathetic Nerve-trunk** in the neck is occasionally compressed by aneurisms or tumours. If merely irritated, dilatation of the pupil on the same side and unilateral sweating of the head and face are produced, but, if divided, the pupil is contracted from unbalanced action of the third nerve. It has also been completely excised on both sides in the treatment of Graves' disease, and the operation appears to be of some value.

## CHAPTER XVI

### SURGICAL DISEASES OF THE SKIN AND OF THE CUTANEOUS APPENDAGES

A **Boil** or **Furuncle** is a limited form of infective gangrene involving merely a small portion of skin and subcutaneous tissue, usually round a hair follicle. Experimentally, a plentiful crop of boils can be produced by rubbing a culture of staphylococci into the skin, and clinically it is supposed that a similar infection through the hair follicles is the most common cause of this condition. The secondary boils around a primary one are without doubt due to the friction upon the healthy integument of dressings, covered with pus and microbes.

People with a coarse skin and a tendency to comedones are specially liable to the occurrence of boils. A gangrenous inflammation ensues after infection, resulting in the death of the hair follicle, or of the sweat or sebaceous gland involved, and of the surrounding connective tissue, and the slough thus formed is cast off by a process of suppuration. A matured or ripe boil, therefore, consists of a central slough or core, a zone of pus around it, and external to this granulation tissue merging into healthy skin and connective tissue. Although infection from without is the local exciting cause, some depression of the vital powers is frequently present, which may lead to recurrence.

**Signs**—A boil commences as a small red irritable pimple, from which a hair may often be seen to protrude, which increases gradually in size, becoming more and more painful, until it forms a conical tumour, deep red in colour and exquisitely tender. A small whitish spot appears in the centre, and around this so-called core yellow pus can be seen. Finally it bursts, discharging the pus, and subsequently the core or slough comes away. The process is then at an end, and the wound rapidly heals by granulation. Occasionally the inflammation extends more deeply into the subcutaneous tissues, constituting a 'carbuncular boil'. Lymphangitis sometimes follows, and the neighbouring lymphatic glands may become sympathetically enlarged and painful, but rarely suppurate. A boil sometimes subsides without suppuration, leaving the parts thickened and infiltrated, the condition then being known as a 'blind boil'.

**Treatment**—Many boils may be left to burst naturally, though possibly the process may be checked by surrounding them with a piece of ordinary adhesive plaster, with a hole over the apex of the

swelling Poultices are generally applied, and the boil is incised when mature The pus should be received on portions of wool soaked in carbolic lotion (1 in 20), and the cavity lightly swabbed out with pure carbolic acid A small collodion dressing is then applied Constitutionally, tonics, such as iron and quinine, are usually required, except in plethoric individuals, in whom a spare diet and abstinence from stimulants may be recommended A change of air to a bracing seaside place is often advisable, especially when a succession of boils has appeared

A **Carbuncle** is a more extensive infective gangrene of the subcutaneous tissues, due to a local invasion with pyogenic microbes, the commonest being the *Staphylococcus pyogenes aureus* It occurs in individuals run down by any general debilitating condition, such as albuminuria or diabetes, in whom the germicidal powers of the tissues are much depreciated, it is also occasionally met with as a sequela of acute fevers The exciting cause may be some blow or squeeze, resulting in extravasation of blood or some local diminution of vitality, into this area cocci are implanted either by auto-infection, or more usually through the sweat glands or hair follicles, or through some slight superficial abrasion

**Signs**—A carbuncle commences as a hard, painful infiltration of the subcutaneous tissues, the skin over which becomes red and dusky The swelling gradually increases in size in all directions, until even a diameter of 6 or more inches is reached As it extends peripherally, the central parts, which were formerly brawny, become soft and boggy, and the overlying skin shows evidences of yielding to the pressure within Vesicles form on the surface, and finally pustules, these in turn burst, and allow a tardy exit to the ashy-gray sloughs and purulent discharge accumulated below Fresh openings gradually develop, leading to a cribriform condition of the cutis, due probably to the passage of the pus along the lines of least resistance, viz, the perforations of the cutis at the sites of the sebaceous glands and hair follicles Some of these apertures enlarge and run into one another, producing a central irregular crateriform opening, at the bottom of which lies the necrotic tissue As the violence of the inflammation subsides, the sloughs gradually separate, leaving a clean granulating wound Carbuncles most frequently occur on the back, the nape of the neck, the shoulders, and nates, where the vitality of the tissues is never very active, when they form on more vascular parts, such as the face and lips, the consequences may be even more serious, since infective thrombosis of the large veins may follow, and this may quickly spread up to the cavernous sinus The soft and spongy tissue of the cheek is a very favourable place for the extension of the necrotic process, and there may be a wide area of mischief under an apparently insignificant superficial lesion A carbuncle is usually single, and may be accompanied by lymphangitis and a painful enlargement of the nearest lymphatic glands

There is often considerable constitutional disturbance of an



asthenic type, although the temperature is not necessarily much raised. Sometimes the gravest symptoms of blood-poisoning (pyæmia or septicæmia) may supervene.

**Diagnosis**—1 *From Boils*—*Pathologically*, a boil is an infective gangrene of a small portion of the skin. A carbuncle affects the subcutaneous tissues primarily, and the skin secondarily. *Clinically*, boils are multiple, conical in shape, more localized, and when suppuration has occurred the process is terminated by the discharge of the pus and slough through a single opening. Carbuncles, on the other hand, are usually single, much larger, flatter, and the sloughing process may continue peripherally, whilst the central part is discharging its sloughs through several openings. 2 *From Gummata*—Cutaneous gummata are frequently multiple, occurring in patients with a distinct syphilitic history. They are not very painful, and do not as a rule attain any great size. They usually ulcerate early, leaving circular sores, or if multiple and confluent, sores with serpiginous outlines, there is generally but little definite sloughing. The deeper gummata are also less painful, have but one opening, and leave excavated sores, in the bases of which are yellowish sloughs like wet wash-leather. The discharge is not distinctly purulent, but more like blood stained gum, unless the sore becomes septic.

The **Prognosis** of a carbuncle mainly depends upon the condition of the internal organs. If the patient is a confirmed sufferer from diabetes or albuminuria, there is always considerable risk of his sinking from exhaustion. The vascularity of the parts also influences the result, as although there is more reparative power about a vascular region like the face, yet the implication of large veins may lead to embolic pyæmia.

**Treatment** must always be of a tonic, supporting character. Good food, iron, quinine, and alcohol according to judgment, must be administered, whilst appropriate medicine (*e g*, codeia or opium) and limitation of diet are necessary in diabetic patients. Locally, many different forms of treatment have been suggested. The most thorough and satisfactory is to lay the carbuncle freely open under an anæsthetic, and scrape with a sharp spoon or cut away all sloughs until healthy tissue is reached, and then to thoroughly disinfect the cavity with pure carbolic acid or peroxide of hydrogen (10 volumes). The hollow thus formed is stuffed with antiseptic dressings, such as gauze soaked in an iodoform emulsion (10 per cent), and the case will then probably do well. Another less radical proceeding is to make a free crucial incision, and allow the sloughs to separate naturally, assisting matters by antiseptic poultices.

In the early stages, it has been proposed to inject the surrounding tissues with pure carbolic acid in the hope of destroying the organisms, and thus preventing suppuration. In a certain number of cases this object will be successfully accomplished, but where the organisms are at all virulent, it will probably fail.

A **Corn** (*clavus*) is a localized outgrowth of the epidermic layer of the skin, together with a central ingrowth of a hard, horny plug,

which compresses and causes atrophy of the underlying papillæ, constituting a cup-shaped hollow, whilst the surrounding papillæ are hypertrophied. It is the presence of this central plug that constitutes the difference between a true corn and a simple callosity or diffuse overgrowth of the epidermis. Any abnormal pressure is capable of producing either condition, granting that it is not sufficiently severe or intense to lead to ulceration, but it is rare to find corns except on the feet, and the chief cause is badly-fitting boots. Two kinds of corns are described, viz, the hard and the soft.

The **hard corn** usually occurs on the little toe, or over the head of the metatarsal bone of the great toe, or over the heads of the first phalanges of the other toes, especially if there is any tendency to hammer-toe. They form more or less conical swellings, with a dark, dry, central plug, and are often very painful, especially when rain is threatening. Suppuration sometimes occurs beneath a corn, and the pain then becomes acute. **Treatment** consists in paring the corn, after softening with hot water or treating with salicylic acid plaster (10 or 20 per cent), or painting with a solution of salicylic acid in collodion\*. A circular ring of felt plaster may subsequently be worn, but attention must be directed to the boots, and the cause of the trouble removed. Occasionally, where the toe is deformed, it is necessary to perform amputation.

A **soft corn** occurs between the toes, and owing to the absorption of sweat the surface looks white and sodden, it is often extremely painful. **Treatment** consists in removing the thickened cuticle after the use of salicylic acid. The parts are very carefully cleansed night and morning, and spirits of camphor painted on at night, whilst cotton-wool is worn between the toes during the day.

**Perforating Ulcer of the Foot** forms on some part of the sole and progresses deeply so as to involve sooner or later the bones and joints. It is usually due to two main factors, viz, *anæsthesia* of the soles, and more or less persistent *traumatism*, such as arises from wearing a tight boot or from the presence of a nail, which is not noticed owing to the concurrent anæsthesia. It is therefore likely to be met with (1) In certain central nervous diseases, *e.g.*, tabes dorsalis, syringomyelia, spina bifida, etc, (2) in diseases such as diabetes, syphilis, alcoholism, etc, which lead to peripheral neuritis, and (3) as a sequence of traumatic lesions of the nerves affecting any portion of their course from the spinal cord downwards. Thus, a short time back one of us amputated a foot which was painful and deformed as the result of a healed perforating ulcer which had involved bones and joints, and

\* The following is a useful formula

R. Acidi salicylici, gr̄ ixx  
 Ext cannabis ind, gr̄ viii  
 Sp vini rect, ℥xv  
 Ætheris, ℥xl  
 Collodion flexile, ℥lxxv  
 M Ft pigm

Sig 'To be painted on with a brush three times a day for a week'—R. CROCKER

was due to a severe lesion of the lower lumbar region, involving the cauda equina, received thirty years previously (4) Perforating ulcer is occasionally due to pure plantar lesions, apart from any nervous influence, *e g*, a suppurating wart or corn, or even a chronic epithelioma. The skin under the head of the first metatarsal is the part most frequently affected, but any spot to which undue pressure is directed may become involved, and not uncommonly several such sores may be seen on the same foot. A corn or callosity first forms, and under this a bursa, in which suppuration takes place, the pus tending to travel not only to the surface, but also deeply, so as to involve bones and joints. A typical perforating ulcer presents the appearance of a sinus passing down to the deeper parts of the foot, the orifice of which is surrounded by heaped-up and thickened cuticle. There is usually but little discharge and often no pain. If allowed to progress without treatment, the bones and joints of the foot may be extensively destroyed, or may be welded together into a solid painful mass, in either case necessitating amputation, but if taken in hand early, a cure can in some cases be established by carefully paring away the thickened mass of cuticle, purifying the sinus, and protecting the parts from pressure.

A **Wart** (*verruca*) is a papillary overgrowth of the skin, which may manifest itself in many different appearances. The common wart is a horny projection about the size of a split pea, usually seen on the hands of young people, its surface may be smooth or irregularly filiform, and its colour varies with the amount of dirt ingrained on the surface. When smooth-topped, they are sometimes extremely numerous, and may be a little difficult to distinguish from lichen planus. In parts where there is a certain amount of moisture warts become soft in character, and form large vascular masses, *e g*, venereal warts. The best method of treating ordinary warts is to paint them with glacial acetic acid, or some other caustic, every two or three days, after softening and removing the horny crust with salicylic acid.

**Verruca Necrogenica** (see p 243)

**Tuberculous Affections of the Skin — Lupus** — Although the term 'lupus' is usually and correctly applied to a tuberculous affection of the skin, yet it is also sometimes employed to indicate any chronic inflammation of the skin which tends to spread, and results in replacement of the cutaneous structures by fibro-cicatrical tissue with or without ulceration. In this place we shall deal with the ordinary **Lupus Vulgaris**, which is universally acknowledged at the present day to be of tuberculous origin.

It is met with in children and young adults, rarely commencing after the age of thirty. Its most common situation is the face, usually starting on the nose or cheek. It is rare on the scalp, but fairly frequent on the trunk and extremities. The mucous membrane of the nose and mouth is also attacked, but in such cases the disease usually spreads to it from the skin. It is rarely symmetrical, except when commencing on the nose.

**Clinical Features** —The earliest manifestation of lupus consists in the formation of one or more shot-like nodules in the deeper layers of the skin, which are surrounded by a zone of hyperæmia and infiltration. These nodules are not particularly hard to the touch, but when of any size can be demonstrated to be of a brownish-orange tint, especially if they are devascularized by the pressure of a glass slide, and then the colour somewhat resembles that of apple-jelly. Gradually the process extends, and usually more rapidly in one special direction, following the course of the vessels. At the same time the integument becomes infiltrated and transformed into granulation or cicatricial tissue, covered by a layer or two of epithelium, and owing either to degeneration of the tuberculous nodules, or to a lack of vitality, arising from compression of the vessels by the contraction of this new formation, ulceration is very liable to follow. In the extremities the lupoid growth not unfrequently takes on a warty aspect, somewhat similar to the 'anatomical wart' occasionally seen on the knuckles of post-mortem porters (p. 243).

A **Lupoid Ulcer** usually spreads at one margin as it heals at the other, and hence under typical circumstances is more or less crescentic in shape, although this is frequently interfered with by various causes. The surface is covered with granulations, often of a protuberant nature. The edges are raised and infiltrated, and scattered lupoid tubercles are readily distinguishable, extending into the healthy tissues, which are usually red and congested. A considerable amount of sero-pus is often secreted, and this by drying forms thick scabs. Any cicatrix which results from natural processes of cure is thin and vascular, easily breaking down from any slight irritation. The process extends gradually, with or without intermissions, from the seat of its first appearance, being, as a rule, distinctly limited to the cutaneous tissues, but when it attacks the nose, the cartilages are often involved and destroyed, whilst if it involves the palate or septum nasi, perforation is very likely to ensue. The disease is practically painless, and does not at first affect the general health. Neighbouring lymphatic glands may become inflamed, and in some few instances are the seat of a tuberculous deposit. Even if left to itself, it tends sooner or later to come to an end, the ulcerated parts cicatrizing, but leaving indelible traces of its ravages in the shape of obvious scars, with often considerable loss of substance. Occasionally it persists, in spite of treatment, and then an epithelioma may in time develop on the site of the mischief, running a rapid course owing to the vascularity of the part.

**Pathological Anatomy** —The characteristic microscopical feature of lupus lies in the formation of nodules around the smaller vessels of the skin (Fig. 112), consisting chiefly of a mass of round cells, within which may perhaps be observed a giant cell and epithelioid cells, arranged in the same way as in tubercle. The structures around are infiltrated and hyperæmic, and as the disease progresses, the original tissue of the part disappears, and is replaced by granulation or fibro-cicatricial tissue. The bacilli are by no means readily found, and are always few in number.

The **Diagnosis** of lupus from syphilitic and other destructive affections of the skin turns on the presence of outlying nodules beyond the spreading edge of the lesion, together with the apple-jelly-like granulations, and the thin, congested character of any cicatricial tissue present, whilst the slow, though continuous, progress, and the tendency to heal at one part as it spreads at another, are also suggestive of its presence. The age and constitution of the individual, and the persistence of the disease in spite of treatment, must also be taken into account.

The **Treatment** of lupus has been greatly modified of recent years, and is now in a much more satisfactory condition than formerly, owing to the discovery of the remedial properties of X rays, Finsen light, and other agents. In the old days free removal of the disease



FIG 112 —SPREADING MARGIN OF A PATCH OF LUPUS (ZIEGLER)

a, Normal epidermis, b, normal corium with sweat-gland (z), c, focus of lupoid tissue, d, vascular nodule surrounded by diffuse cellular infiltration, e, non-vascular nodule, f, strings of cells in course of lymphatics, g, lupoid ulcer, h, proliferating epithelium

was recommended, either by knife, sharp spoon, or caustics, but the results were poor, recurrence being common and the cosmetic effect bad, since healthy and diseased tissues were removed together.

The *Finsen-light cure* consists in exposing the lupoid tissue to concentrated electric- or sun-light, which is focussed on the skin through an inverted telescope, and finally passes through a rock-crystal chamber full of cold running water, so as to eliminate the heat rays. It is important that the water-chamber should be pressed firmly against the skin so as to devascularize it during the application. Each sitting lasts for one and a quarter hours, and an attendant whose eyes are shielded by dark glasses controls the crystal water-chamber, keeping it firmly against the skin, and slightly shifting it from time to time so that an area about as large as a shilling shall be acted upon.

at each séance. Slight inflammatory phenomena follow, and a local leucocytosis supervenes, as a result of which the disease disappears, and a soft supple scar is produced, which is very little obvious. It is plain that this treatment is very expensive and tedious, and requires constant watchfulness on the part of the operator. It has been found of most value where ulceration is absent and the patch not of great size.

*X-ray treatment* is also valuable. The same precautions as to protecting healthy parts must be observed as in treating cancer (p 210). The best results have been obtained by using a tube of comparatively low vacuum, and by working for a definite inflammatory reaction, and then stopping till this has disappeared. The length of the exposures necessarily varies, but, as a rule, three to six exposures a week of not more than ten minutes each will suffice. The X rays appear to act best on the ulcerative and fungating forms of lupus, which clear up and heal over, but the cure is only up to a point, as the scars are frequently found to contain small nodules over which the rays have no further influence. For these the Finsen light may be employed beneficially, but in the absence of this agent they may be dealt with by scraping with a lupus spoon, and subsequently applying solid nitrate of silver, acid nitrate of mercury on a match end, chloride of zinc as a paste, or even the actual cautery.

In some bad cases with much ulceration and when there is a superabundance of granulations it may be wise to remove these with a sharp spoon as a preliminary measure, and then hand the patient over to the radiographer. The surgeon must remember, however, that he is not operating to cure the disease, but merely to lay bare the deeper tissues in order that the rays may reach them more effectively. He must not include in the scope of his operation healthy tissues.

For positions which are inaccessible to the ordinary means of applying X rays or electric light—*e g*, the back of the throat, the interior of the nose, etc.—the high-vacuum electrode of the high-frequency machine, which gives off X rays, is useful.

Whilst this light treatment is proceeding, the patient's health must be attended to, and a course of suitable tonics administered. An open-air life, as nearly assimilated to the sanatorium type as possible, is also desirable.

**Lupus Erythematosus** is a disease the nature of which is not yet satisfactorily determined. The appearance of the affection is tolerably characteristic, it is usually situated on the face, and in the most typical cases symmetrical patches are formed over the root of the nose and cheeks, corresponding in appearance to a butterfly with outspread wings. There is a considerable tendency for it to invade the forehead, ears, and scalp, and it occasionally appears on the trunk, and may then be unilateral. It appears as a smooth hyperæmic surface, covered with a branny desquamation, the scales consist of inspissated sebum, and are continuous with deep plugs, which can be traced into the mouths of enlarged sebaceous follicles. As the disease spreads peripherally, the older and central portions are transformed into cicatricial tissue of a pale, thin and white type, in

marked contrast to the hyperæmic condition of the advancing margin. It is usually seen in adults, and more frequently in women than men. Progress is exceedingly slow, and ulceration uncommon, except when the ears or scalp are involved, in the latter region the hair is often lost. Epithelioma has also been known to follow this affection.

The **Treatment** consists in attention to the general health, together with the local application of weak tarry and mercurial preparations. The X rays and Finsen light act rapidly, but must be used with caution, since the inflammatory disturbance caused by them is considerable.

The so-called **Tuberculous Ulcers** differ from the lupoid in the fact that they always result from the breaking down of a subcutaneous focus, and hence may be connected with diseases of bones, joints, lymphatic glands, or simply of the connective tissues. Their characters and treatment have been already indicated (p. 164).

Other cutaneous manifestations of tubercle are recognised, but need scarcely be mentioned here.

### Affections of the Nails

**Onychia** is almost always due to the infection with pyogenic or other organisms of the matrix, starting at the side or base of the nail under the semilunar fold. Two varieties are described.

1 **Onychia Purulenta** (*Paronychia*, or *Ungual Whitlow*) is an affection of the matrix commonly seen in surgeons and nurses, in which suppuration occurs beneath the nail, which is thereby loosened, the individual attacked is generally out of health. The condition usually starts on one side, and gradually extends round the semilunar fold and beneath the nail, until the whole matrix may be affected. When the loosened nail is cut away, it is found that the diseased portion of the matrix is converted into granulation tissue. The process is extremely painful and somewhat tedious. The only hope of checking its progress lies in removing with fine scissors, possibly under an anæsthetic, all the loosened portion of the nail, and then touching the exposed granulations with nitrate of silver, whilst the most comforting applications are without doubt linseed-meal poultices, possibly made with hot carbolic lotion (1 in 40), and frequently repeated. At the same time the general health must be attended to.

2 **Onychia Maligna** is the term applied to a somewhat similar condition met with in badly-nourished children, who are perhaps syphilitic. The whole matrix is transformed into granulation tissue, whilst the digit becomes swollen and club-shaped. Treatment consists in avulsion of the nail from its bed, and the application of antiseptic fomentations or poultices, together with iodoform.

**Ingrowing Toenail** is an ulcerative condition of the soft parts curling over the side of one of the toenails (usually that of the great toe), and due either to the pressure of pointed or badly-fitting boots, or to neglect in trimming the nails. The fold of skin is thus pressed by the boot over and against the nail when the patient walks, and in order to

diminish the pain and irritation caused thereby, he often cuts away the projecting angle of the nail, but leaves a deep corner which still further irritates the soft parts. Ulceration ensues, accompanied by an offensive discharge and so much pain as to prevent the patient from walking. The matrix of the nail may also become inflamed, and onychia result. In the earliest stages, further progress can often be prevented by careful attention to the nails, by the use of square-toed boots fitting easily, and by introducing small plugs of aseptic wool to press back the overhanging fold of skin. When ulceration is actually present, the best plan to adopt is the removal of the affected half of the nail under local or general anæsthesia, giving special attention to the extraction of the projecting angle. If there is much discharge, it is also wise to cut away the overhanging fold of skin with scissors, and scrape away any granulations present. The parts are then dressed antiseptically, and in a few days the patient is able to walk about. Where there is no ulceration, a cure can sometimes be effected by excising an oval portion of skin from the side of the toe and close to the nail. The edges of the incision are drawn together by horsehair, and thus the overgrowing fold of skin is drawn away from the nail (Fig 113).

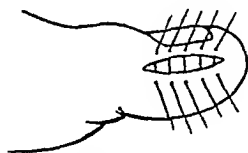


FIG 113

The term **Onychogryphosis** is applied to a hypertrophic condition of the nails, which become distorted and bent, or twisted up, perhaps simulating a ram's horn. It is usually limited to the great toes of elderly people, and is due to neglect. The nails are very rough, and often covered with grooves or ridges, whilst beneath them is an accumulation of soft, offensive epithelium. The only treatment is removal.

### Affections of the Sebaceous Glands

**Sebaceous Cysts** occur on any part of the surface of the body, but especially the scalp, and are due to obstruction of the duct of a sebaceous gland. They are rounded swellings, firm and elastic to the touch, moveable on the deeper structures, and always attached at one spot to the skin. On careful examination, the obstructed mouth of a sebaceous follicle can usually be seen, and possibly some of the contents of the sac squeezed through this opening. The cyst wall is formed by several layers of epithelium, surrounded by dense fibro-cicatrical tissue, and if exposed to irritation or pressure, as when situated on the back or shoulder, and rubbed by the braces, becomes very firmly adherent to the surrounding parts. The material contained within is of a cheesy, pultaceous consistency, with a peculiar stale odour, yellowish-white in colour, and under the microscope is seen to be composed of fatty and granular debris, epithelial cells, and cholesterol. Left to themselves, the cysts may attain considerable dimensions, whilst the walls and contents sometimes become calcified. Occasionally the exudation oozes through the duct, and dries on the



surface, with just sufficient cohesion to prevent it from falling off, layer after layer of this desiccated material is deposited from below, finally giving rise to what is known as a **Sebaceous Horn**. These become dark in colour from admixture with dirt, and are always more or less fibrillated in texture, the base, to which they are firmly adherent, is infiltrated and hyperæmic. Sebaceous cysts sometimes inflame and suppurate, sooner or later they burst or are opened, and then the process subsides. They are occasionally cured in this way, but more frequently the cyst fills up again, and the same series of phenomena are repeated after an interval. Should the contents only partially escape, the remainder is liable to undergo putrefactive changes, giving rise to an offensive ulcerated surface with raised edges, which may readily be mistaken for epithelioma. It is sometimes known as *Cock's Peculiar Tumour*. True malignant disease of an epithelomatous nature is said occasionally to supervene.

*Diagnosis* — From a *dermoid cyst* it is known by the facts that the dermoid is congenital in origin, that it is limited to certain localities, whilst it is hardly ever directly attached to the skin. From a *fatty tumour* it is recognised by the absence of lobulation, and by its more solid character, whilst a lipoma is softer and more moveable. From a *chronic abscess* it is distinguished by the dilated orifice, by its firmer consistency, and by the history, but it is sometimes impossible to be certain before incising it.

*Treatment* — A sebaceous cyst should be entirely and completely removed if giving rise to any disfigurement, inconvenience or pain. In the scalp all that is needed is to transfix the tumour, squeeze out the cheesy contents, and then the cyst wall can be readily removed by grasping it with dissecting forceps and pulling it away. In other situations the cyst wall may require to be dissected out, but even then it is advisable to open it by transfixion, and to deal with the sac from below rather than from above. Horns and fungating ulcers should be excised with the surrounding skin.

Sometimes a true **sebaceous adenoma** may develop in connection with these cysts. It may be slowly growing and of a firm, solid consistency, but sometimes it is much more vascular and grows rapidly. The latter has a form of semi-malignancy in that it is very liable to recurrence, and has therefore often been mistaken for a sarcoma. On microscopic section it closely resembles a rodent ulcer, but its clinical history is quite distinct. Its most frequent situation is the scalp, and it requires to be removed with a free hand, the defect in the scalp being made good by Thiersch-grafting.

**Molluscum Contagiosum** — This affection shows itself in the form of a number of firm hemispherical nodules, a little larger than a split pea, usually of a yellowish white colour, and very definitely umbilicated. The depression in the centre may be occupied by dry débris, and from the larger ones a waxy mass may be expressed. They are usually seen on the face, but may involve any part of the surface of the body. There seems no doubt as to their contagious properties, this being perhaps best seen in the development of growths of this nature on a

mother's breast, secondary to those on the face of her baby. The cause of the contagion is by no means certain, whilst the exact nature of the affection is also more or less in dispute, since, although some authorities consider it sebaceous in origin, others are equally insistent that it commences in the hair follicles or deep layers of the rete. Pathologically, the tumours consist of numerous wedge-shaped lobules of polygonal, nucleated, epithelial cells, supported by a fibrous stroma. The cells towards the centre undergo a waxy or hyaline degeneration, and in them are seen numerous rounded bodies, which have been supposed to resemble psorosperms. *Treatment* consists in cutting or pulling them away, or in cutting them across, and squeezing the contents out from the well-defined capsule.

## CHAPTER XVII

### AFFECTIONS OF MUSCLES, TENDONS, AND BURSÆ

#### Injuries of Muscles and Tendons

**Contusion** — Muscles are bruised as a result of blows or falls, leading to more or less extravasation, with possibly some rupture of the fibres. The part becomes tender and swollen, and any active contraction gives rise to pain, passive movement, however, is tolerated, if the injured fibres are not thereby put on the stretch. Fomentations and rest may be needed for a few days, but friction, with stimulating embrocations and liniments, and regular massage of the parts, are subsequently necessary.

**Sprains and Strains**, due to violent efforts or falls, result in the tearing or stretching of some of the fibres. Considerable stiffness follows, especially in rheumatic and gouty patients. Rest and either hot or cold applications may be used at first, but friction with liniments and passive movements will be needed later. In individuals predisposed to the development of tuberculous disease, special precautions must be taken to ensure complete recovery.

**Rupture of the Sheath** of a muscle is an accident occasionally met with, especially in the biceps cubiti or rectus femoris. The belly of the muscle, when contracted, protrudes through the opening as a hernia, constituting a soft semi-fluctuating swelling. In treating this condition the limb must be kept at rest in such a position as to relax the muscular fibres and allow the rent in the fascia to heal. In old-standing cases it is justifiable to cut down and expose the opening in the muscular sheath, the edges of which are sutured together, or if this cannot be effected a sterilized sheet of silver foil may be stitched over the defect.

**Displacement of Tendons** rarely occurs, except in parts where these structures pass through osseo-fibrous canals, and particularly in those where the line of action is thereby changed. During some violent effort the patient feels a sudden localized pain, followed by a certain amount of limitation of mobility. This accident is popularly known as a 'rick'. In superficial parts the displaced tendon can sometimes be distinctly felt in an abnormal position, and this becomes more evident on attempting to move it. Thus the long tendon of the biceps may be dislocated from the bicipital groove, and various

tendons about the wrist or ankle, especially that of the peroneus longus, may similarly suffer. If left alone, the parts settle down more or less comfortably, but some permanent weakness may persist, recurrence is very likely to ensue if movement is permitted before the newly formed connections have had time to consolidate.

**Treatment** consists in fully relaxing the muscles and replacing the tendon, if possible, by manipulation. The parts are then immobilized and well supported for six or eight weeks by a plaster of Paris splint or strapping. If the displacement recurs, it is sometimes advisable to cut down, expose the tendon, and stitch it back into position, using early passive movement to prevent the formation of troublesome adhesions. This is required most frequently in the case of the peroneus longus tendon, which slips forwards from its groove behind the external malleolus. The external annular ligament is thereby ruptured, and the operation consists either in suturing the divided segments, or in more aggravated cases it may be necessary to turn down a flap of periosteum from the malleolus and by stitching its apex to the outer side of the os calcis secure the tendon in place.

**Rupture of Muscles and Tendons** is by no means uncommon, resulting from excessive violence of a sudden and unexpected nature. Most frequently the tendon gives way at its union with the muscular belly, less often the belly itself yields, whilst occasionally the tendon may snap, or the point of bone to which it is attached may be torn off.

**Signs**—The patient at the moment of the accident experiences a sharp and severe pain, as if he had been struck with a whip, he may also feel or hear a snap. Loss of function follows, together with a certain amount of swelling and bruising, which is more evident if the muscular fibres have been torn across than if the tendon alone has been lacerated. On attempting to contract the affected muscle, the belly rises up as a soft, rounded, semi-fluctuating tumour, drawn towards the uninjured attachment, if the union between the tendon and belly has given way, whilst if the lesion has been through the muscular substance, the divided halves of the belly become similarly prominent, and a distinct gap or sulcus can be felt between them.

Repair is established in the usual way already described (p. 245), viz., a cellulo-plastic effusion is first poured out, taking the place of the blood-clot, which is absorbed, this becomes vascularized into granulation tissue, and finally cicatricial tissue is developed. Where a muscular belly is involved and the ends are much separated, a long and weak bond of union is likely to form, but when they are closely apposed, the cicatrix is a short one, and may sooner or later be replaced by true muscular tissue. When a tendon has been divided or torn, the connecting medium is at first attached to the sheath, and if this adhesion persists, it may lead to much pain and weakness. It is an exceedingly interesting fact to note how rapidly this tissue attains a considerable degree of strength, a rabbit's tendon ten days after division requires a weight of 56 lbs. to break it (Paget).

**Treatment**—It is essential to relax the parts fully so as to prevent separation of the divided ends, and to maintain them in this position

for two or three weeks. Any resulting stiffness is combated by passive movements and massage, whilst, if need be, adhesions are broken down under an anæsthetic. Tendons accidentally divided in open wounds should be sutured together by catgut, special antiseptic precautions being adopted to prevent suppuration along the tendon sheaths. Where there has been actual loss of substance in a tendon,

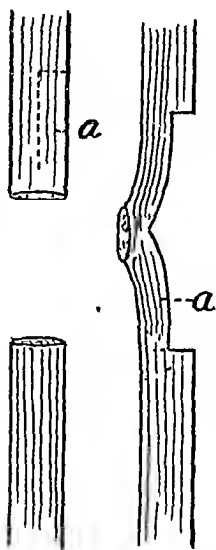


FIG 114.—METHOD OF UNITING TENDON AFTER LOSS OF TISSUE BY TURNING DOWN A PORTION OF IT AS A FLAP

it is possible to remedy the defect by grafting a portion of tendon from another patient, or from an animal, between the two ends, or, again, one end may be split longitudinally in such a way as to leave a thin flap attached peripherally, so that the free end (*a*) can be turned down and united to the other segment (Fig 114). Care must be exercised to prevent opposing muscles from dragging on and stretching the new bond of union, as thereby considerable functional disability may result. Thus a young man had his anterior tibial muscles divided by a stab with a knife, they were carefully sutured together, but during convalescence the foot was allowed to drop, the result being that the muscles and tendons were stretched, and hence the most vigorous contractions had no effect in raising the toes, which dragged along the ground. A second operation to shorten all these structures was required.

When muscular bellies have been divided, it is not difficult to secure them, if the fibres have been severed longitudinally or obliquely, but when the section is transverse, there is a great tendency for the stitches to cut out. In such a case it is advisable to encircle with a ligature a bundle of muscular fibres on either side of the incision, and then tie the two threads together. This must be done at several spots in the cross section.

The *long tendon of the biceps* is not unfrequently torn from the muscular belly, which, on attempting to bend the arm, is drawn down towards the elbow, constituting a soft tumour, somewhat resembling a lipoma. No special treatment is needed beyond keeping the fore-arm flexed for a time. If the *tendo Achillis* is ruptured, union may be attained by keeping the knee bent and the heel raised, as by securing a strap to the back of a slipper below, and to a dog-collar passed round the knee above. A better result, however, would follow an aseptic incision and suture. Similarly, if the *ligamentum patellæ* gives way, suture through an open wound is more satisfactory than mere elevation of the leg and rest. The *inner head of the gastrocnemius* is sometimes torn in wrenches or slips, as at lawn tennis, and the *plantaris* is similarly affected. Cooling lotions are applied for a few days, and the parts are kept at rest until the tender-

ness and swelling have in part subsided, and then regular massage is undertaken. The *adductor longus* may be lacerated in violent attempts to maintain a seat on horseback, and constitutes one form of riders' sprain, it is treated by rest and the application of a firm spica bandage.

### Diseases of Muscles

**Inflammation of Muscles (Myositis)** may arise from a variety of circumstances, but the chief results are alike, whatever the cause, viz, a more or less painful infiltration of the muscle, with increased discomfort on attempting movement. The part feels hard and rigid, and may be tender to the touch. If suppuration ensues, the ordinary signs of an abscess subsequently make themselves evident. A certain amount of contractile tissue is thereby destroyed, and the cicatricial changes induced will possibly lead to deformity.

**Varieties**—1 **Simple Traumatic Myositis** results from contusion or laceration of the fibres, and is merely a plastic inflammation, with or without hæmorrhage, running on to resolution, with perhaps a little fibroid thickening of the part. It is liable in some cases to become chronic, the muscle substance becoming shortened and replaced by fibrous tissue (*M. fibrosa*), and this fibrosis may extend beyond the limits of the original lesion. The induration of the sterno-mastoid muscle met with in children is of this type, and may lead to torticollis. In other cases ossification of a limited portion of the muscle or tendon may occur from long-continued and frequently-repeated irritation, thus, in riders (male) the upper portion of the adductor tendons may in this way become bony, constituting the so-called 'riders' bone'. Sir William Bennett\* has pointed out that a similar type of sprain followed by inflammation and wasting of the muscles occurs in women from riding, involving the hamstrings (particularly the biceps), and possibly being mistaken for sciatica.

2 **Rheumatic Myositis** usually results from exposure to cold, e.g., wry-neck from sitting in a draught. It is treated by fomentations and ordinary saline anti-rheumatic remedies, whilst later on friction with stimulating embrocations is needed.

3 **Acute Suppurative Myositis** is the outcome of infection with pyogenic organisms, either from without, as after operation wounds, punctures, gunshot injuries, gangrene, etc., the pus in such cases spreading widely up and down the muscular planes, or from within the body, as in pyæmia, or by extension from neighbouring suppurative foci, as from subperiosteal abscesses, it may also arise after a contusion or sprain by auto-infection. Great cicatricial deformity is likely to follow.

4 **Chronic Tuberculous Myositis**, with the formation of a chronic abscess, is not an uncommon secondary consequence of a similar affection of neighbouring bones or joints—e.g., a psoas abscess.

5 **Syphilitic Disease** is usually met with in the tertiary period, and takes the form either of a diffuse sclerosis or of a localized gumma.

\* *Clinical Journal*, November 9, 1904.

Any muscle may be affected, but perhaps the tongue and sterno mastoid are those most frequently involved. Care is needed in making a diagnosis, since these conditions resemble tumours in their method of onset, but the presence of a syphilitic history, the slow growth, the hardness, with subsequent central softening, and the rapid disappearance after the administration of iodide of potassium, should suffice to determine their nature.

Occasionally gummata appear in muscles in the shape of small hard and shotty nodules, usually arranged more or less longitudinally, which are painless and apparently attached to the fascial sheath. They react readily to iodide of potassium.

6 **Parasitic Myositis**, arising from the presence either of the *Trichina spiralis* or of hydatids, need not be described here.

7 **Myositis Ossificans** is a rare disease, in which various muscles, especially those of the back, are transformed into bony plates or rods, so as to lead to extensive ankylosis. The process seems to be one of ossification of the connective tissue associated with atrophy of the muscular fibres, and is sometimes extremely painful. It is most commonly seen in young males, and is possibly rheumatic in origin. In a boy recently under observation the arms were immobilized by ossification of the latissimus dorsi muscles on either side, whilst the pectoralis major was also ossified on the right side. The erector spinæ was involved, the back being thus rendered rigid, and the right trapezius was undergoing the same change. This disease is not unusually associated with a congenital deformity of the great toes in which the proximal phalanx is absent or stunted. No treatment has proved of any value.

**Tumours of Muscles** are not very common. Primary growths consist of angioma, fibroma, chondroma, myxoma, or sarcoma, and of these the majority start in the fibrous sheaths or the interfibrillar connective tissue. Secondary deposits of both carcinoma and sarcoma occur, but there is nothing special to be noted about them. *Treatment* must be determined on ordinary surgical principles. If sarcomatous, the whole thickness of the muscle should, if possible, be excised for some distance from the growth, since the lymphatics run in the direction of the fibres, but the sheath forms a limit not early overstepped. Amputation of the limb may, however, be required.

### Diseases of Sheaths of Tendons

The synovial membranes which line the sheaths of tendons may become inflamed as a result of injury or infection.

1 **Acute Simple Teno Synovitis** often follows sprains and strains, and is most commonly seen in connection with the extensor muscles of the thumb. A puffy swelling in the course of the tendons is produced, painful on movement and perhaps tender to the touch, giving a characteristic fine crepitus whenever the parts are moved. All that is needed for its **Treatment** is to immobilize the limb for a few days, and apply fomentations. As soon as the more acute

symptoms have disappeared, friction with stimulating embrocations and pressure are employed to hasten the absorption of the fluid, whilst active and passive movements are undertaken to prevent the formation of adhesions

2 **Acute Suppurative Teno-Synovitis** may result from a punctured wound of the synovial sheath, or the inflammation may spread to it from neighbouring tissues. The thecal variety of whitlow (p. 244) is of this nature. Suppuration may extend both up and down the sheath, and unless promptly treated by incision, the tendon will slough, or may contract extensive adhesions to neighbouring parts, in either case considerable impairment of function follows. The suppuration may affect neighbouring articulations, leading to their disorganization, especially in the case of the tendon sheaths around the wrist-joint.

3 **Chronic Simple Teno-Synovitis** is a common affection, characterized by a passive effusion into the tendon sheath of glairy synovia, somewhat resembling uncooked white of egg. It may be limited in extent, constituting one of the varieties of ganglion, or diffuse. An elastic fluctuating swelling forms in the course of a tendon, usually associated with creaking. There is no pain or tenderness, but the affected part feels weak. **Treatment** consists in counter-irritation and pressure, as by Scott's dressing; failing this, the part may be freely incised, the synovia removed, and, if need be, the cavity washed out. In the more localized forms it may suffice to puncture the cyst-like swelling and squeeze out the contents, pressure being subsequently applied.

4 **Chronic Tuberculous Teno-Synovitis** is of two types. In one the sheath is lined by œdematous granulation tissue of some thickness, containing tuberculous foci, giving rise to a soft elastic swelling along the course of a tendon, which increases slowly in size, and is but slightly painful or tender. Suppuration may follow, and subjacent bones or joints be involved. **Treatment** consists in immobilizing the part, pressure, and improvement of the general health. If a cure is not quickly established, a free incision should be made and the diseased tissue removed.

The other form of tuberculous disease consists in a passive effusion into the synovial space, the lining membrane of which becomes thickened by the deposit thereon of fibrinous material. This is often detached, and by the movements of the part the loose fragments of fibrin are moulded into various shapes. In tendon sheaths they are often elongated, and constitute the so-called *melon-seed bodies*, but when they occur in joints, they remain somewhat flattened, and in bursæ approximate more to the spherical. On examination, they are found to be structureless, though sometimes laminated. When numerous they give rise to a curious and characteristic form of crepitus. That they are of a tuberculous nature can be demonstrated by inoculation experiments, the bacilli contained therein are not, however, in a very active state, and the prognosis of this type is more favourable than of the former.



If **Treatment** by immobilization and pressure (as by the application of Scott's dressing) fails, the part should be opened, the effusion, including fibrin and melon-seed bodies, removed, iodoform gently rubbed in, and the cavity closed, after filling it with glycerine and iodoform emulsion. Should the trouble recur, a free incision and removal of the diseased membrane may be required.

A **Ganglion** is the term given to a localized cyst-like swelling forming in connection with a tendon sheath. It is most commonly met with at the back of the wrist, arising from the tendons of the thumb or index-finger, but it sometimes occurs on the front of the wrist or in the foot. It varies in size considerably, and contains a clear, transparent gelatinous or colloid substance, like white-currant jelly. A rounded firm elastic swelling is produced, usually somewhat moveable, and neither painful nor tender at first, although some painful weakness of the part may be experienced as it increases in size. It is due to one of several causes: thus, it may result from a chronic localized teno-synovitis, or from a hernial protrusion of the synovial membrane through an opening in the tendon sheath. Others seem to originate in a colloid degeneration of the cells lining the synovial space, whilst certainly some few arise in connection with subjacent articulations, in the same way as a Baker's cyst. Little difficulty arises in the diagnosis, although, when situated deeply and closely attached to a bone, they have been mistaken for exostoses. **Treatment**—A ganglion may often be ruptured by manipulation and pressure with the thumbs, or by a forcible blow with a book, but it is apt to fill again. Failing this, a rapid cure is usually obtained by an aseptic puncture of the cavity, and the subsequent application of firm pressure. In some cases it may be advisable to lay the part open and remove the cyst wall, such treatment requires absolute asepsis, since, if infection occurs, most serious consequences may ensue.

A **Compound Palmar Ganglion** consists in a tuberculous affection of the common synovial membrane surrounding the flexor tendons of the wrist, the cavity being distended with synovia, usually containing many melon-seed bodies. It forms a large swelling extending above and below the wrist, fluctuation being readily transmitted from one part to the other beneath the annular ligament, it also extends amongst the muscles of the thenar eminence along the tendon of the flexor longus pollicis (Fig 64). In the **Treatment**, rest and pressure, as by Scott's dressing, together with suitable constitutional remedies, may first be tried, and failing this, an incision is made both above and below the annular ligament, the cavity being well washed out, and all melon-seed bodies and fibrinous debris removed. The cavity is then filled with the glycerine and iodoform emulsion, some of which may be gently rubbed into the pockets of the wound, both incisions are then firmly sutured, and a further period of rest maintained. Should the skin become thin and undermined, drainage may be required, and even in a few cases division of the annular ligament, in order to deal effectively with the trouble by the sharp spoon. The results, however, are not very good, as the tendons get matted together and adherent to the skin, and the movement of the fingers is thereby hampered.

### Operations on Tendons

1 By **Tenotomy** is meant the division of a tendon through an open or subcutaneous wound with the object either of remedying some deformity, such as talipes or torticollis, or of assisting the surgeon to reduce some displacement, as in setting a fracture, thus, the tendo Achillis may require division in fractures of the leg in order to overcome muscular contraction

Division of tendons is accomplished in two ways, viz, by subcutaneous or open incision. The **subcutaneous** method is made use of where there is little likelihood of injuring important structures. The strictest attention to asepsis is desirable, since the character of the wound, viz, a puncture, and the entire absence of drainage are most favourable to the development of organisms, if entrance is once given to them. Moreover, the synovial tendon sheath is often, though undesignedly, wounded, and septic inflammation would rapidly spread along this structure, and give rise to the most serious consequences. The operation consists in inserting a sharp-pointed tenotome through the skin down to the tendon. This is then withdrawn, and a blunt-pointed knife passed along the track thus made, either superficial to or beneath the tendon. The cutting edge is turned towards it, and the tendon divided by a sawing or rocking movement, whilst the structure is put on the stretch by an assistant. Every effort must be made to avoid opening the sheath, since even if the wound remains aseptic, the tendon often retracts more than is desirable, and in healing gains adhesions to the sheath which considerably limit the subsequent freedom of movement of the part. Opinions vary as to whether it is better to pass the knife above or below the tendon, in the former method there is no likelihood of making an unduly large wound in the skin, and there is less risk of dividing the *lax* subjacent structures if the knife is turned towards them. On the other hand, if the knife is at once passed beneath the tendon, and any such subjacent structures are by mistake included, their division is a matter of certainty. Where, however, there is any risk of dividing important structures, such as the external popliteal nerve in tenotomy of the biceps cruris, it is wiser to adopt the **open method**. In this an incision about 1 inch in length is made over the tendon, which can thereby be exposed, lifted on an aneurism needle, and severed without danger. There is no hæmorrhage worth mentioning, and the wound is closed by a point or two of suture, dressed antiseptically, and firmly bandaged to prevent extravasation. The malposition is at once corrected, and the part immobilized at the time, or in the course of forty-eight hours, in plaster of Paris.

*Tenotomy of the Tendo Achillis*—The foot is placed on its outer side, and the tendon relaxed by pointing the toes downwards. The tenotome is introduced at the inner margin of the tendon, about 1 inch above its insertion (Fig 94, F), either superficial to or beneath it, and it is readily divided when the foot is dorsiflexed. If the surgeon cuts towards the skin, he must not divide the last few fibres too

rapidly, otherwise a considerable external wound may be inflicted by the suddenly liberated knife

The *Tibialis Anticus* is usually divided about 1 inch above its insertion, as it crosses the scaphoid (Fig 96, C) There is here no synovial sheath, and the *arteria dorsalis pedis* is separated from it by the tendon of the *extensor proprius hallucis* It is first relaxed so as to allow of the introduction from the outer side of the sharp-pointed tenotome beneath it, this is then replaced by a blunt-ended instrument, and the section is readily accomplished when the foot is abducted

The *Tibialis Posticus* is usually divided together with the *fleur longus digitorum* just above the base of the inner malleolus, at a spot about a finger's breadth from the tip of that process in an infant, and about  $1\frac{1}{2}$  inches from it in an adult (Fig 94, E) A small tubercle can usually be felt at this spot, and the section must be made just above The knife is inserted between the tibia and the tendon, and is kept as near the bone as possible If correctly placed, it remains fixed without the support of the hand, being grasped between the tendon and the bone The blunt-ended tenotome is then introduced, and the edge being turned towards the tendon, the latter structure is divided when the foot is dorsiflexed The posterior tibial vessels may be wounded if the tendons are too suddenly severed, but even should this occur, a little well-adjusted pressure will suffice to prevent any serious consequences

The *Peronei* tendons are divided just above the base of the outer malleolus, at a spot where the synovial sheath is usually absent (Fig 95, D) The tenotome is inserted close to the fibula, between the tendons and the bone

The *Biceps Cruris* tendon is best divided by an open operation, on account of the close propinquity of the external popliteal nerve, which has often been wounded in the subcutaneous operation An incision is made in the direction of the tendon just above its insertion into the fibula It is then lifted upon an aneurism needle and divided, muscular fibres will probably be found quite close to its lower end

The *Semi-membranosus* and the *Semi-tendinosus* tendons are dealt with just above the knee-joint, and the subcutaneous operation may be conveniently adopted when they are prominent and tense

For division of the *Sterno-mastoid*, see p 422

2 **Lengthening a Tendon** is sometimes required, in order to overcome the deformity which results from loss of substance or contraction, where simple tenotomy does not seem desirable It may be possible to utilize the method suggested on p 408 for the union of a tendon where there has been loss of substance, viz, by bridging the interval by a flap turned down from one end Perhaps a more efficient method is the so-called **Z-operation** (Fig 115) The tendon is split longitudinally (*bc*) into two halves, which are separated one from the other by cross cuts made on opposite sides, one at each end (*ab* and *cd*) The two flaps are then drawn apart for a distance corresponding to the increase in length required, and sutured together, the resulting bond of union will be as represented in Fig 116

3 **Shortening a Tendon** is undertaken in some forms of paralytic talipes. The **Z-method** may also be employed here, the two halves, after they have been separated, being shortened to the required amount, and then stitched together (Fig 117). This operation will probably give a more solid bond of union than the simpler proceedings in which either a transverse or an oblique section is removed, and the ends sutured together, in such the sutures are much more likely to cut out.

4 **Tenoplasty**, or the incorporation of a strong tendon into a weaker one in order to strengthen it, is rarely undertaken except in talipes, and more particularly in order to reinforce a weak tendo Achillis in paralytic talipes calcaneus, by joining to it a strong and healthy

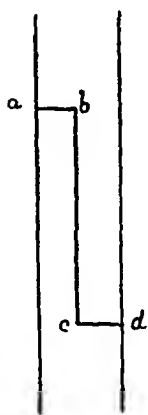


FIG 115

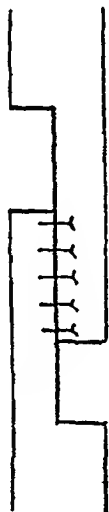


FIG 116

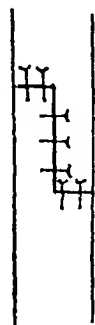


FIG 117

FIGS 115, 116, AND 117 —Z-OPERATION FOR LENGTHENING OR SHORTENING OF TENDONS

In Fig 115 the method of dividing the tendon is shown. In Fig 116 the flaps are slipped downwards, one on the other, so as to lengthen the tendon. In Fig 117 equal portions have been cut away from each half, and the remainders sutured, so as to shorten it.

**peroneus longus**. In order to make an effective bond of union, the healthy tendon must be threaded through the weak and atrophic one, and fixed by sutures in several places.

### Diseases of Bursæ

Bursæ exist as normal structures in many parts of the body exposed to pressure, their object being to diminish friction and permit of a gliding movement. Similar cavities, known as abnormal or **Adventitious Bursæ**, are developed in regions where exceptional pressure is brought to bear on some prominent structure, they consist of a fibrous wall lined by a serous membrane, contain a small quantity of serum, and are formed either by dilatation of lymphatic spaces, or as

a result of a localized effusion into the tissues. Examples of this are met with in men following special occupations, *e.g.*, over the vertebra prominens of Covent Garden porters, and then known as a 'hummy'; Billingsgate fish-carriers occasionally have bursæ under the centre of the scalp, and deal runners often present one on the upper part of the shoulder. They occur over bony prominences arising from malformation or displacement, *e.g.*, over the cuboid, in talipes equinovarus, over the internal condyles of the femora, in bad cases of genu valgum, whilst the false joint or pseudarthrosis which occurs in unreduced dislocations or ununited fractures is practically of this nature.

**Wounds** of bursæ may be caused by penetrating injuries, or sometimes by the skin over them splitting, as, *e.g.*, in a fall on the point of the olecranon. The escape of bursal fluid which results often prevents healing, and then it will be necessary either to excise the bursa, or to open it freely so that it can be stuffed and made to granulate from the bottom.

The following are the morbid conditions which arise in adventitious as well as normal bursæ.

1 **Acute Simple Bursitis** may result from a non-penetrating injury, or from prolonged irritation, especially in gouty or rheumatic individuals. The part becomes swollen, painful, and tender, and if superficial the skin over it may be hyperæmic. Effusion into the cavity quickly occurs, the fluid being spontaneously coagulable in the early stages, and, if resulting from traumatism, mixed with blood. Lymph is deposited on the serous surface, and in many cases results in the formation of adhesions, and possibly obliteration of the cavity. **Treatment** consists in keeping the part at rest, and applying fomentations, whilst suitable constitutional remedies are administered. If the effusion persists, aspiration, or removal with trocar and cannula under strict asepsis, may be employed, or even the whole cavity excised.

2 **Acute Suppurative Bursitis** arises from infection occurring either from without or within, it not uncommonly follows a subcutaneous injury of a chronically inflamed bursa, leading to its distension with blood. All the phenomena, local and constitutional, usually associated with the formation of a superficial or deep abscess are present. The pus, formed at first within the bursa, may travel directly to the surface, or, bursting through the capsule, is diffused through the tissues. Where this occurs, the characteristic features suggesting a bursal origin of the abscess may be masked. Thus, in suppuration of the bursa patellæ, the pus often finds its way to the lateral aspects of the limb, allowing the patella to be distinctly felt through the skin, the case might then be mistaken for suppuration within the knee-joint, but is easily distinguished by the absence of the more acute arthritic symptoms. Implication of subjacent bones and joints sometimes occurs, thus, the patella or olecranon may become carious, or necrose. The **Treatment** of suppurative bursitis resolves itself into an early free incision, and drainage.

3 **Chronic Bursitis with Effusion** is, perhaps, the most common pathological condition met with in connection with bursæ. The

cavity becomes distended with a serous effusion of varying amount, giving rise to a fluctuating tumour. The walls differ in thickness according to circumstances, if the condition is one of long standing, or if frequent recurrences have been present, the bursal wall is usually reticulated and dense, and adhesions or fibrous cords are often produced. Subacute exacerbations are frequently grafted on the more chronic variety. **Treatment** consists in rest and counter-irritation, as by blistering or iodine paint, and if this fails, the bursa should be dissected out. When the bursa communicates with a joint, such as that under the semi-membranosus tendon, the neck must be isolated, and its communication with the joint shut off by ligature.

4 **Chronic Fibroid Bursitis**—In this variety the walls of the bursa become chronically thickened, as a result of prolonged irritation, and also probably from the effect of syphilis. There is but little effusion, consequently, a hard fibroid tumour is met with in the region of the bursa, and in the centre of this is a small cavity. The only **Treatment** is complete removal.

5 **Chronic Tuberculous Bursitis** occurs either in the form of a fibrinous deposit on the inner wall, together with effusion and the presence of loose fibrinous bodies, or the lining membrane undergoes a change analogous to that described as pulpy degeneration of a joint, and perhaps leading to the formation of a chronic abscess. Either condition may be secondary to a tuberculous arthritis, or may give rise to it, when the bursa communicates with a joint. If total removal is impracticable, the **Treatment** consists in laying the part freely open, scraping away all tuberculous tissue, and stuffing the cavity with gauze impregnated with iodoform.

6 **Syphilitic Changes** may also occur in bursæ, in the shape either of a symmetrical bursitis in the early stages, or later on as a gummatous peri-synovial development.

Occasionally **Gouty Deposits** are observed in the walls of bursæ, constituting tophi, the irritation of which may predispose to abscess formation, pus mixed with urate of soda crystals being discharged. The bursa over the olecranon is said to be most frequently affected in this way.

### Special Bursæ

The *bursa patellæ* (Fig 118), which lies over the lower half of the bone and not over its centre, is very liable to injury and inflammation from its exposed situation, and especially in those who kneel much, giving rise to the condition known as 'housemaid's knee'. Any of the above-mentioned varieties of bursitis may be met with, and their signs are so evident that it is unnecessary to again mention them in detail. The relation of the bursa to the patella explains the fact that acute suppuration sometimes gives rise to caries or superficial necrosis of that bone, whilst chronic and subacute inflammations may lead to thickening of the bone from osteoplastic periostitis.

The *bursa beneath the ligamentum patellæ* between it and the head of the tibia, when distended with fluid, gives rise to a fluctuating swell-

ling felt on either side of the tendon, more especially when the limb is extended, when the leg is flexed, the swelling diminishes. Chronic enlargement of this bursa may cause the ligamenta alaria to be pushed backwards into the joint, so that they are nipped between the bones whenever the patient attempts to stand with the leg extended, the pain thereby induced is somewhat similar to that caused by a displaced semilunar cartilage, or by a loose foreign body in the joint. The inability to stand with a straight leg, and the presence of the enlarged bursa, are sufficient, however, to guide the surgeon to a correct diagnosis.

The *bursæ in the popliteal space* are often enlarged, especially that between the inner head of the gastrocnemius and the semi-membranosus, leading to a rounded fluctuating swelling, sharply limited on its outer aspect, and more fixed and less defined towards the

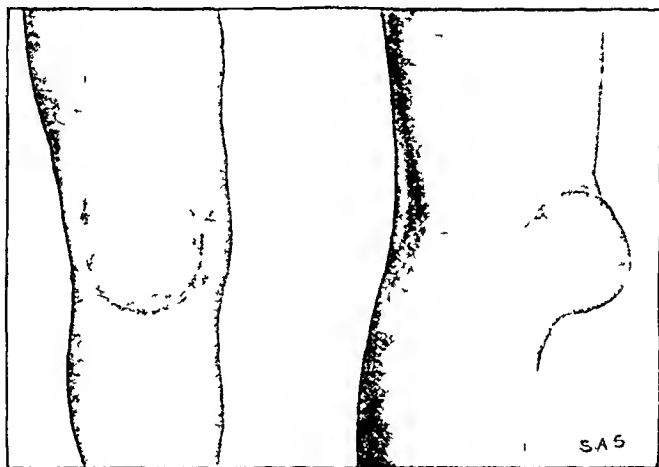


FIG 118 —ENLARGED BURSA PATELLÆ (FROM A PHOTOGRAPH)

inner. The sensation imparted to the fingers varies according to the position of the limb, the swelling being *tense in extension and flaccid in flexion*, as occurs in most of these peri-articular bursæ. Owing to the proximity of the popliteal vessels, pulsation is occasionally detected, but it is only heaving, not expansile, in character. The fact that the bursa usually communicates with the joint necessitates considerable caution in its treatment, it should be removed by a careful dissection, the communication with the joint being closed by ligature or suture.

The *bursa beneath the insertion of the semi-tendinosus and gracilis* is sometimes inflamed, and is very liable to cause osteoplastic periostitis of the subjacent inner surface of the tibia.

The *bursa beneath the tendo Achillis*, if enlarged, presents a fluctuating swelling on either side of that structure, somewhat simulating disease of the ankle-joint, but necessarily limited to the posterior aspect of the joint. The enlargement is usually due to the pressure of badly-fitting boots.

Distension of the *bursa beneath the psoas tendon* gives rise to a fluid

swelling which usually projects anteriorly, presenting on the inner side of Scarpa's triangle. If painful, it necessitates flexion of the thigh, and thus leads to symptoms resembling those of hip-joint disease or of a psoas abscess. It must not be forgotten that this bursa often communicates with the joint.

The *gluteal* bursa, situated between the insertion of the gluteus maximus and the great trochanter, is not uncommonly the seat of tuberculous disease. It presents as a rounded swelling, obliterating the hollow behind the trochanter, and in its more acute manifestations may be accompanied by abduction and eversion of the limb, in order to relax as far as possible the gluteus. It may thereby somewhat resemble the earlier stages of hip disease, but is known from it by the absence of flexion, and the fact that passive movements, including even the so-called test-movement for hip disease, can be undertaken with but little or no pain. Should suppuration occur, the pus may burrow widely beneath the gluteus. Treatment consists of incision, which will necessarily involve a portion of the insertion of the gluteus maximus, scraping and disinfecting the interior of the bursa, and allowing it to heal from the bottom.

The *bursa over the tuber ischi*, if inflamed, gives rise to the condition known as 'weavers' bottom', it causes great discomfort in sitting, and is often solid and symmetrical. If troublesome, it should be removed.

Enlargement of the *bursa over the olecranon* constitutes the condition known as 'miners' or students' elbow', suppuration within it is not uncommon, leading to necrosis of the underlying bone, the elbow-joint is but rarely affected.

The large multilocular *subdeltoid bursa* is occasionally enlarged, it leads to prominence of the deltoid, and expansion of the shoulder (For diagnosis from effusion into the shoulder-joint, see p 648). Where treatment by counter irritation and rest fails, the cavity should be incised and drained.



## CHAPTER XVIII

### DEFORMITIES

#### Torticollis

TORTICOLLIS, or wry-neck, is a deformity produced by a contraction of the sterno-mastoid muscle, the trapezius and deep fascia being also frequently affected, and occasionally the short muscles at the back of

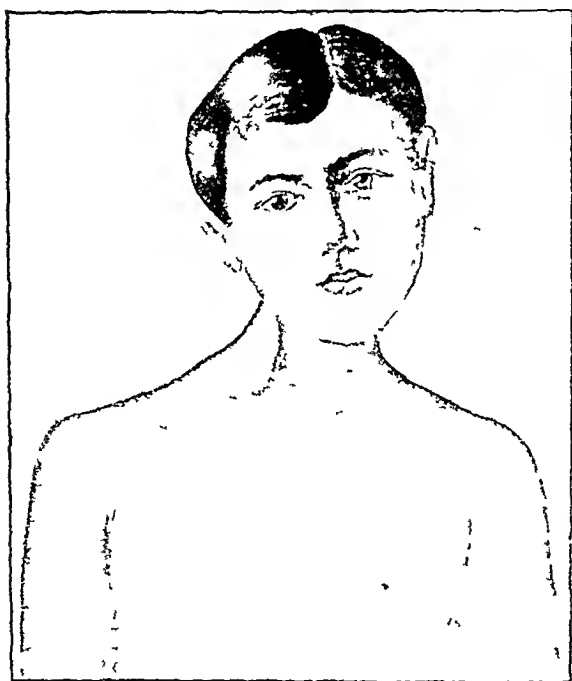


FIG 119 — TORTICOLLIS

The right sterno mastoid is contracted and the corresponding half of the face atrophic

the neck It is characterized by the affected side of the head being drawn down towards the shoulder, whilst the face is turned towards the sound side, as shown in Fig 119 When this has lasted for some time, especially in congenital cases and those commencing in childhood, the affected side of the head and face becomes atrophic The measurement from the external canthus to the angle of the mouth is smaller, the eyebrow is less arched, the nose deflected, and the cheek less full than on the sound side No very satisfactory explanation of these phenomena is forthcoming, but they are probably due to

imperfect vascular supply The cervical spine becomes laterally curved, with its concavity to the affected side, and a secondary compensatory curve is also present in the dorsal region, so as to maintain the eyes as far as possible on a level

The **Causes** and **Varieties** of torticollis may be classified as follows

1 *Congenital* torticollis, the result of malformation or malposition *in utero*, or of some intra-uterine muscular contraction or nervous lesion

2 *Muscular* torticollis, due to intrinsic contraction of the sterno mastoid, apart from nervous influences, as in cicatricial shortening after intramuscular abscess or gumma. In children it is said to follow the congenital induration of the muscle so often seen, and due to laceration during birth, whilst it is not unfrequently met with as a temporary deformity resulting from cold (rheumatic myositis, or stiff-neck)

3 Torticollis arising from *nervous* causes, including spasm and paralysis. *Spasmodic* torticollis (tonic or clonic) may result (a) from the direct irritation of the nerve-trunk or its roots, as by inflamed cervical glands or cervical caries, (b) possibly from reflex irritation, as by carious teeth, worms or ovarian mischief, and (c) from irritation of the deep or cortical centres. This latter variety is usually of the clonic type, and often involves the posterior muscles as well as the sterno-mastoid. The character of the movements varies with the actual muscles involved. It occurs most frequently, though not exclusively, in women of about thirty years of age, and there is often a family history of nervous diseases, such as epilepsy, etc. The prognosis in these cases is almost always unfavourable, since, even if the localized spasm is cured by appropriate operative treatment, other parts are likely to become affected. *Paralytic* torticollis arises either from infantile paralysis of one muscle, leading to unbalanced action of that on the other side, or from some peripheral nerve lesion

4 *Hysteria* is also responsible for a certain number of cases

Most commonly the sternal portion is mainly affected, whilst the clavicular half may be quite relaxed. In congenital and cicatricial cases the muscle stands out as a hard tense band, an excess of fibrous tissue being present, or the muscular substance almost entirely absent, but in spasmodic cases the muscle may be well developed and not specially prominent. The deep fascia always becomes secondarily contracted and shortened, and if the deformity has lasted long the posterior cervical muscles are similarly affected, whilst changes in the shape of the vertebræ may also be induced, the bodies becoming wedge shaped and thickest towards the convexity of the curve

The **Diagnosis** of torticollis is readily made. It must not be confounded with cicatricial contraction of the skin of the neck following burns, or the attitude temporarily assumed by a patient with an acute deep seated abscess of the neck, or with tuberculous caries of the spine associated with lateral deviation. The rigidity of the neck in the latter case, together with the pain caused by movement of or pressure over the vertebræ, should suffice to make the diagnosis clear. Rheumatic inflammation of the deeper ligaments and muscles of the cervical spine (rheumatic spondylitis) may also be mistaken for torticollis, but it comes on rapidly, and is associated with tenderness on deep pressure. The fact that in tonic cases the muscle is evidently

contracted, and stands out as a tense band in the neck, is sufficiently characteristic. Spasmodic torticollis, again, cannot well be mistaken for any other condition, but it may be difficult to distinguish its cause or to localize the affected muscles.

The **Treatment** of torticollis necessarily varies with the cause, and thus either antiphlogistic, antineurotic, antirheumatic, or antisiphilic remedies may be required. When, however, it is due to congenital or tonic contraction of the muscle or its tendon, massage and manipulation may be first tried, or even some form of mechanical apparatus, but in the majority of cases tenotomy or myotomy will give a more satisfactory result, and is much less tedious and troublesome.

Two methods of dividing the sterno-mastoid have been employed. (1) The *subcutaneous* operation is a somewhat undesirable proceeding, on account of the important structures placed immediately beneath it. There is but little danger or difficulty in dealing with the sternal head, a tenotome being passed down to it beneath the skin, and the incision made from before backwards, the tension to which it is exposed suffices to draw it well forwards out of harm's way. In dealing with the clavicular portion, it has been recommended to introduce a sharp-pointed, and then a blunt-ended, tenotome beneath the muscle, dividing it from within outwards, whilst others suggest that a director should first be passed beneath it, and then the muscle divided. (2) The *open* method is far preferable to any of these plans, as thereby all danger is obviated. The skin is freely incised across the muscle, its anterior and posterior borders defined, and its fibres carefully and fully divided. No attempt should be made to deal with the portion of deep cervical fascia which passes beneath it and securely covers in the important underlying structures. Any part of the lower half of the muscle may be selected, but the best spot is about  $\frac{1}{2}$  inch above the clavicle. The position of the head is then rectified, and fixed by plaster of Paris or some other suitable apparatus. A simple and satisfactory arrangement consists of a padded leather strap passed round the forehead and occiput, and another under the axillæ. A chain or elastic band is secured to the forehead strap above the mastoid process of the side which is not affected, and traction made by fixing it to the front of the lower belt on the opposite side of the body. Thus, if the left sterno-mastoid is contracted and has been divided, the chain is attached over the right mastoid process above, and below over the front of the left axilla, traction being thus made in the direction of the right or weakened sterno-mastoid muscle. In some cases more efficient support is necessary, and may be obtained by the use of Chance's back splint (p 429), to which arms are attached at the upper end, bringing pressure to bear upon each side of the head in suitable directions. Where, however, osseous changes are present, the deformity may persist to a great extent, in spite of combined operative and mechanical treatment.

In cases of clonic torticollis it may be necessary to cut down on, and stretch or excise, the spinal accessory nerve (p 386). This is

not attempted until hygienic and tonic treatment has failed. Where the cause is peripheral, good results may follow, but when due to central lesions, as is usually the case, we have already stated that failure is not uncommon. In such, division of the posterior cervical nerves, as they lie on the semi-spinalis colli, will occasionally bring about a cure (Keen), should this fail, it may be justifiable to deal with the cortical centres.

A **Cervical Rib** is a deformity of somewhat unusual occurrence. It arises most frequently from the anterior transverse process of the seventh cervical vertebra, but a similar outgrowth sometimes occurs from the sixth. It is mainly composed of cartilage at first, but as age advances it becomes osseous. It passes down behind the nerves to unite with the central portion of the first rib, and occasionally consists of two portions, an upper and a lower, united together by a synchondrosis. No symptoms are produced until the mass by its growth compresses the roots of the brachial plexus, or pushes the subclavian vessels forwards, thus leading to trophic and vascular disturbances, as well as to neuralgia and some weakness or loss of power in the arm. Nothing should be done to this condition unless pressure symptoms are present, when removal may be required. An incision is made parallel to the anterior border of the lower portion of the trapezius, the nerves and vessels are separated from the mass of cartilage and drawn aside, and the growth carefully excised with gouge, chisel, or cutting pliers.

### Deformities of the Spine

**Scoliosis**—By scoliosis is meant a lateral curvature of the spine accompanied by rotation of the vertebrae. Conditions are met with in which the spine becomes deflected laterally as an occasional result of Pott's disease, or in fractures, such, however, are not generally considered to be genuine scoliosis.

**Ætiology**—The following are the chief causes of scoliosis. 1. It is said to occur very rarely as a congenital deformity, owing to malformation of the vertebrae. 2. It may commence in young children as a result of *rickets*, owing partly to the softened condition of the bones, partly to their irregular growth. It is probably often induced by the method of always carrying children on the same arm in vogue with nursemaids. A similar change, due to the so-called 'delayed rickets,' may also occur in children who are able to run about. The primary curve in this type is usually one directed towards the left in the dorsi-lumbar region. 3. Any condition of asymmetry of the body may lead to what is known as *statical scoliosis*, e.g., congenital shortness of one leg, unilateral dislocation of the hip, contractions of the knee- or hip-joints, genu valgum, falling in of the chest wall as a result of empyema, and even old-standing torticollis. If the cause exists in one of the lower extremities, the pelvis is tilted down on the side of the shorter limb, unless persistent adduction is also present, producing a lumbar curve with the convexity towards the side of the

shortened leg, whilst a compensatory dorsal curve in the opposite direction is subsequently added in order to maintain the general axis of the body. When due to empyema, a primary dorsal curvature is produced, with its convexity towards the sound side. In torticollis the cervical curve is primary, and a compensatory curve in the opposite direction in the dorsal region usually follows. 4. The most common type, however, is the *scoliosis-of-adolescents*, met with in young people about the age of puberty, or a little older, who are in a weak and asthenic condition, often as a result of rapid growth, combined possibly with improper or insufficient food, defective hygienic surroundings, or exposure to hard work, whereby undue muscular fatigue is induced. Young women of an anæmic type who suffer from amenorrhœa, and who as housemaids or factory hands have to undertake a good deal of lifting, are especially liable to this condition. It is due to a relaxed state of the ligaments and muscles, which have not developed *pari passu* with the weight and length of the skeleton, it is therefore not unfrequently associated with flat foot and genu valgum. Prolonged standing in a position of ease or rest, in which the weight is mainly carried on one leg, may determine its occurrence, as also faulty positions occupied by children at school, owing to low desks and want of support to the feet. The lumbar curve usually forms first, its convexity being to the left side, a compensatory dorsal curve, with its convexity to the right, being subsequently developed.

The **Phenomena** vary considerably according to the character and extent of the lesion. Sometimes the whole spine is involved in one curve (*total scoliosis*), but more usually two curves are present, one primary, the other compensatory. It is by no means uncommon for this condition to be associated with kyphosis, but the absence of the latter, in what is sometimes termed the 'flat-backed' type, is no criterion of the slightness of the case. The most usual variety is that in which there is a double curve, with the dorsal convexity to the right and the lumbar to the left. It will be desirable to describe this carefully, whilst for the opposite condition all that is necessary is to transpose the words 'right' and 'left,' or, as Hoffa has put it, one variety is the 'mirror picture' of the other.

In addition to the lateral displacement, *rotation of the bodies of the vertebræ* (Fig 121) towards the convexity of the curves is always present. This is probably a purely mechanical act, and due to the more firm support given to, and the interlocking of, the posterior parts of the vertebræ. As a result, the spinous processes are directed towards the concavity, and hence will always indicate a smaller amount of distortion than really exists. Occasionally there may be some backward projection of the spines at the junction of the two curves.

The *thoracic walls* necessarily participate in the process. The ribs on the right side become to some extent separated from one another, and project posteriorly on account of the rotation of the vertebræ, the amount of curvature at the angle is consequently increased, whilst the front of the chest on this side of the body becomes flattened. On the left side the ribs are huddled together, and the curve at the angle

diminished, the ribs being thereby opened out, consequently, the thorax is flattened posteriorly on that side, but projects in front, the left breast may thus be rendered prominent (Fig 122). In fact, the thorax becomes more or less rhomboidal in shape. The sternum also is somewhat displaced towards the concavity, and twisted so that the anterior surface looks towards the right. The capacity of the thorax is not as a rule affected at first, but in the later stages it is consider-

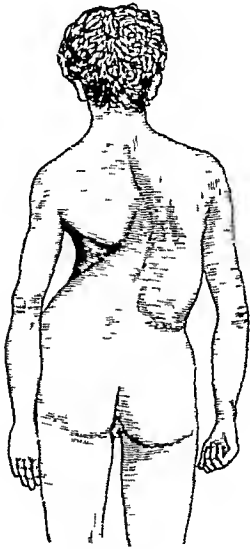


FIG 120—SCOLIOSIS SEEN FROM BEHIND (TILLMANN'S)

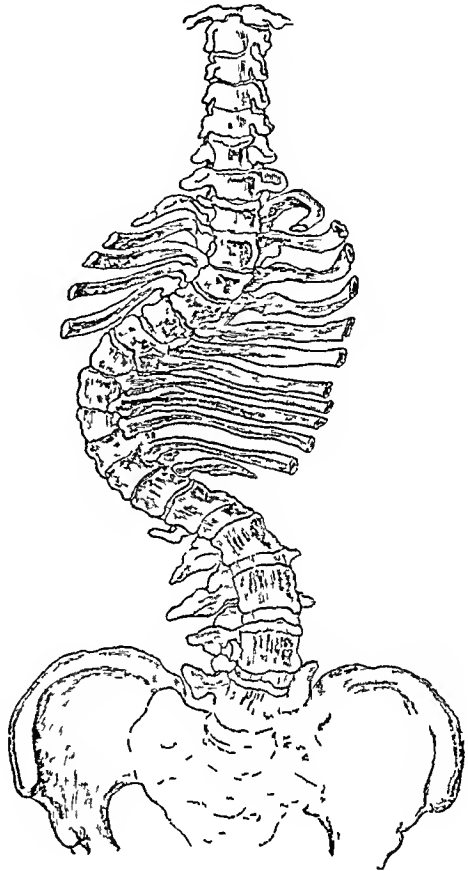


FIG 121—SPINE IN SCOLIOSIS SEEN FROM IN FRONT (TILLMANN'S)

ably diminished, and the abdominal viscera may even be displaced. The *scapulae* follow the thoracic wall, and hence the right shoulder is pushed upwards and outwards, and thus, it is said, in the worst cases may progress to such an extent as to cause the sternal end of the clavicle to be spontaneously dislocated backwards. It is for this 'growing out of the shoulder' in young women that the majority of cases come under observation. The left scapula is generally somewhat lower than the right. The effect on the *waist* varies with the situation and extent of the curves, if the dorsal and lumbar curves

are nearly equal, then the true waist on the right side becomes more marked than usual, corresponding to the lumbar concavity, and in advanced cases a distinct sulcus may be present between the lower ribs and the crest of the ilium. On the left side the hip appears

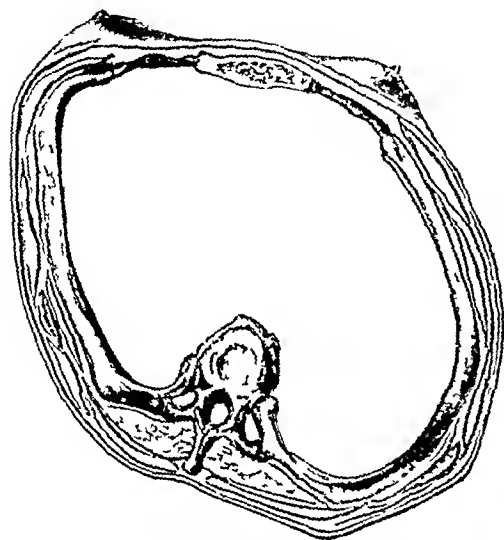


FIG 122 —SECTION OF THORAX IN SCOLIOSIS (AFTER HOLMES AND HULKE)

to project ('growing out'), owing to the deflection of the trunk towards the right side, whilst the dorsal concavity higher up may simulate a false waist. In addition to the above phenomena, the buttocks may be noticed to be asymmetrical, if the scoliosis is of statical origin. The erector spinæ muscle stands out unduly on the left owing to the rotation of the vertebræ, whilst the transverse processes on this side may be unusually evident.

In the early stages the characteristic deformity disappears on extension of the trunk, as by hanging from a trapeze, or on bending for-

wards, but as it progresses, the spine becomes more and more fixed, and but little alteration is produced by suspension of the patient. In the worst cases the deformity becomes so marked as to simulate the 'hump' formed in Pott's disease, especially when associated with kyphosis and the patient's stature becomes dwarfed and stunted.

*Subjective symptoms*, such as neuralgic pain and weakness, are also present, but usually they are not very prominent features.

**Anatomical Changes** — The structure of the spinal column is at first not manifestly altered, but as soon as the deformity becomes chronic, the individual vertebræ become misshapen. The bodies are somewhat wedge-like on section, being thicker on the convex than on the concave side. The *intervertebral discs* are similarly changed, whilst the *articular processes* are unduly pressed together on the concave side, and separated from one another on the convex. The transverse and spinous processes are also approximated to one another on the side of the concavity, and often curved. The *ligaments*, which in the early stages are relaxed, become secondarily shortened on the concave side, and may indeed disappear, the bodies of the vertebræ being ankylosed. The *muscles* are also relaxed in the early stages, but accommodate themselves afterwards to the altered curves of the spine, and hence are contracted on the concave side and stretched on the convex.

It is most essential that a correct **Diagnosis** be made as soon as possible, since so much depends upon early treatment. A thorough

examination should be made with the clothes stripped to below the waist, so that the whole back can be seen. The patient should be made to sit straight up on a stool or chair placed sideways, and the surgeon stands behind her. The general appearance is first noted, and then the spinous processes are marked out one after another with a spot of ink or with a flesh pencil. The shape of the thorax, the curvature of the ribs, and the position of the scapulæ, are also ascertained. The patient is then made to stand, to hang from a bar, and to bend forwards, and the effects of these respective movements noted, by this means some idea can be obtained of the extent and nature of the deformity. There can be but little risk of mistaking it for Pott's disease, since the rigidity, deformity, and localized pain of the latter are so characteristic, in those cases of scoliosis, however, where there is a projection of the spinous processes backwards, a mistake might easily arise if only a careless examination were made.

The **Prognosis** necessarily varies with the stage which the affection has reached. In early days, before the deformity has become set, and when it disappears on extension of the spine, it is almost certain to be entirely cured, if suitable precautions are taken. Later on it can be improved to some extent, but in bad cases all that can be expected is to prevent it from getting worse.

In the **Treatment** of scoliosis, the cause of the trouble must not be overlooked, since in many cases the deformity may be remedied, or at any rate prevented from increasing, by attending to this. Thus, inequality in the length of the limbs necessitates the wearing of a high-heeled boot, whilst contractions of the knee- or hip-joints should, if possible, be remedied. In that variety which occurs in young people from constitutional or local debility, the general health must be improved by a visit to the seaside, or the administration of tonics, such as iron and arsenic. Carefully-regulated rest and exercise must also be recommended, so as to improve the muscular tone of the back without unduly fatiguing the patient, for a similar reason massage and cold baths are beneficial. All errors of position must be corrected, and suitable desks, forms, and chairs utilized. In the slighter cases it often suffices to order the patient to rest in the supine position on an inclined board for an hour or two daily, the head being thus raised and the spine extended. Calisthenic movements and gymnastic exercises, especially on the horizontal bar and trapeze, are also valuable. Of course, these must be arranged so as to exercise the weak muscles and counteract the deformity. Space forbids us describing them here, and we must refer readers to special textbooks. A spinal support is often useful, but should not be worn continuously, except in bad cases, as it renders the muscles of the back weak from disuse. All that is needed in the early stages is the support of a firm, carefully-fitted corset, but should the deformity increase, stronger steel instruments may be employed in which springs are incorporated, whereby it is hoped that correction of the curvature may be brought about. In the more severe cases, which are often associated with considerable pain, such a contrivance with aillary



crutches is absolutely essential. Plaster of Paris, applied according to Sayre's method, is certainly objectionable, since it is irremovable, and all other local treatment to the back is thus prevented.

**Kyphosis**—By this term is meant a condition of increased dorsal convexity of the back (Fig 123), which is often associated with loss of the lumbar concavity, so that the whole spine is arched backwards. Occasionally, however, a marked lumbar lordosis is present as a compensatory condition.

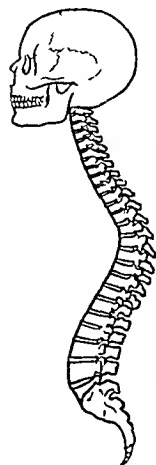


FIG 123 —  
KYPHOSIS

The chief varieties of kyphosis are as follows

1 Kyphosis from defective growth or habit. This may occur (a) in children under the age of four, resulting from rickets, (b) in adolescents up to the age of sixteen (round shoulders), from a continuous habit of stooping, as in reading or writing, especially in those suffering from myopia, (c) various forms of occupation, which involve the carrying of heavy weights, or stooping over work, lead to its appearance in adults, as in porters and cobblers, (d) in old men it results from senile atrophy.

2 Kyphosis from general diseases of the spine is a marked feature in osteo-arthritis, osteitis deformans, osteo-malacia, hypertrophic osteo-arthropathy, and acromegaly. In the latter disease the condition is limited to the dorsal region.

3 Kyphosis from localized disease of the spine is sometimes described, although it is more commonly known by the contradictory term 'angular curvature'. It results from fractures, Pott's disease, gumma, or cancer (qv).

Treatment is impossible in the majority of cases, but the round shoulders of young people come so commonly under observation that a little more notice of the condition is needed.

**Round Shoulders** occur most frequently in girls who have grown rapidly, and perhaps developed precociously. The condition is often due to defective habits of sitting and standing, especially at school, and may be induced by faulty desks and chairs, whilst other intrinsic conditions, such as myopia or adenoids, may also be primarily responsible. The spine becomes bent forwards in the cervico-dorsal region, at first the deformity can be voluntarily corrected, but not so later on.

**Treatment**—In the first place the cause must be ascertained, and, if possible, removed, in particular, chairs and desks must be arranged so as to insure that the child sits in a good position. The essential point in the treatment is to increase the power of the muscles of the back, especially the trapezi, the erectores spinæ, the rhomboides, and the serrati. This may be accomplished by massage, electricity, and exercises, the latter necessarily directed towards extension of the back. The girl should never be allowed to fatigue herself unduly, and must rest on her back two or three times a day for half an hour. At night she should lie on her back, without a bolster, and with a pillow beneath the curve. The general nutrition and health must also

be attended to, and a course of suitable tonics prescribed. In bad cases where the deformity is marked and it is feared it may be progressive, a light support may be required, a Chance's splint\* will do as well as any, but of course the exercises must be persisted in.

**Lordosis** (Fig 124) consists in an increased anterior curvature of the spine in the lumbar region. It is usually produced by continued flexion of the hip, whether due to congenital displacement, to unreduced dislocation, or to hip disease, and in such cases it is irremediable unless the malposition of the femur can be corrected.

It is seen as a temporary condition in pregnancy, and as a more constant phenomenon in bad cases of uterine fibroids, owing to the increased weight of the uterus or its contents, necessitating backward displacement of the upper part of the spine in order to adjust correctly the centre of gravity of the body. The same may be noticed in persons with large, fat, and pendulous abdomens.

It is occasionally present in progressive muscular atrophy where the lumbar and abdominal muscles are weakened, and usually in pseudo-hypertrophic paralysis from loss of power in the gastrocnemii and other muscles engaged in maintaining the erect posture. In both cases the centre of gravity of the body is displaced forwards, necessitating the throwing backwards of the head and shoulders in order to maintain the equilibrium.

**Spondylo-listhesis** is the term applied to a curious and somewhat uncommon deformity, in which the lumbar vertebræ slip forwards and downwards from the top of the sacrum. It arises from fracture of the articular processes of the lumbo-sacral synchondrosis, or from imperfect development of the laminae or pedicles of the lowest lumbar vertebra, as a result of which the pressure of loads carried on the shoulders or the weight of a pregnant uterus brings about the displacement. In the latter instance the enforced lordosis aggravates this tendency. The effects produced are shortening of the stature, together with the formation of a marked hollow above the sacrum, whilst the lumbar vertebræ are unduly prominent anteriorly. The condition is accompanied by neuralgic pain and weakness. The only treatment is prolonged rest in the recumbent posture, and possibly the application of a leather jacket, moulded to the pelvis, and supplied with crutches, so as to carry part of the weight downwards from the axillæ to the pelvic support without utilizing the spine.

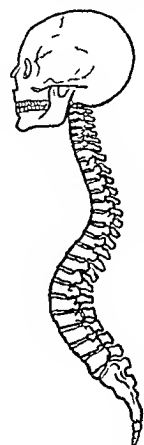


FIG 124 — LORDOSIS

\* Many modifications of Chance's original splint have appeared, but the essential features of all are the presence of a metal pelvic band, from which rises a single or double bar of malleable iron, fitted to the back, and capable of having its curve altered. Lateral supports spring from the central bars or bar, and straps to fix it in position are also provided.

## Deformities of the Upper Extremity

**Congenital Elevation of the Scapula** (Sprengel's Shoulder) is a condition to which some attention has been recently attracted. The scapula may be normal in size or a little smaller than usual, but is situated above its proper position, thereby causing some deformity, and is generally rotated so that its lower angle is approximated to the middle line. The muscles attached to its upper border are prominent, in a few instances an osseous band has replaced them, passing between the upper angle of the bone and the seventh cervical vertebra. The lower third of the trapezius is often defective, as also the serratus magnus. The amount of disability, which is usually slight, depends on the condition of these muscles, but the affected arm is sometimes smaller than its fellow. A slight degree of scoliosis develops as a compensatory phenomenon. The condition is supposed to result from abnormal intra-uterine pressure in the same way as congenital torticollis and talipes. The only treatment consists in dealing with the affected muscles by operation, if necessary. This deformity is distinguished from the 'growing-out shoulder' of ordinary scoliosis by the muscular defects, by the slightness of the scoliotic curve, and by the congenital origin of the lesion.

Various types of **Club-hand** occur, in which the hand is deflected to one or the other side, or is hyper-extended or flexed. Perhaps the most frequent cause is a *congenital absence of the radius*, under which circumstances the hand is radially abducted to a marked degree, the ulna is shortened and curved, and its lower epiphysis much altered in shape and expanded, so as to articulate with the carpal bones. Where the bones are normal, the hand is usually flexed and adducted towards the ulnar side. In any of these deformities skiagraphy should be employed, so as to ascertain the exact relation of the bones to each other.

**Congenital Deformities of the Finger** are much more common, and the account here given of such defects of the upper extremity applies with equal force to those which occur in the lower. The following varieties may be alluded to.

**Polydactylism** consists in the presency of supernumerary fingers and toes. There may be from one to seven additional digits, and the condition is usually symmetrical. One case is on record with twelve and thirteen fingers on the hands, and twelve toes on each foot. The accessory digits are often stunted, and smaller in size than the normal, but may be of average dimensions. Usually they are separated from the true digits, but now and then may be blended with them. The correct number of metacarpal and metatarsal bones may be present, or they also may be multiplied. In one of our cases there were six digits and six metatarsal bones, but the last two digits were supported by an accessory metatarsal apparently springing from the outer side of the fourth. The condition is frequently inherited. The **Treatment** consists in removing the supernumerary digits, if useless, obtrusive, or troublesome. Sometimes the patients are proud of their abnormality, and refuse to part with it. A patient with two weak

thumbs may sometimes be benefited by uniting them laterally into a single broad one

**Ectrodactylism**, or the absence of one or more of the digits, is occasionally seen, as also partial arrests of development of fingers or toes, or intra-uterine amputations at a higher level

**Macroductyly** (Fig 125) consists in a congenital overgrowth of one or more fingers or toes. The structures are perfectly normal in character, and merely gigantic in size for the age of the individual



FIG 125 —MACRODUCTYLY AND SYNDACTYLY

In this case a child, aged two and a half years, had the ring and middle fingers united laterally into a huge mass which projected far beyond the others. The middle finger was normal in size, the ring finger was hypertrophic. A fruitless attempt was made to save the middle finger, but both had finally to be amputated.

Amputation may be needed in these cases, as the deformed parts grow out of all proportion to the neighbouring tissues. Thus, an infant with enormous overgrowth of the second toe of the right foot was successfully treated by excision of the digit, together with a V-shaped portion of the foot, which was by this means reduced to normal shape and size.

**Syndactylism**, or webbed fingers, is a condition in which two or more

fingers are joined together laterally, either by a thin web consisting mainly of skin, or by a thick fleshy bond of union. In the foot no *treatment* is required, but in the hand the fingers must be separated. If there is merely a thin web, this may be divided by scissors, but to prevent its re-formation from above downwards, as healing proceeds, a flap of skin must be transplanted into the angle between the fingers, or an opening in the base of the web may be made and maintained, and the edges allowed to cicatrize before the web itself is divided. Where the union, however, is thick and fleshy, a more extensive operation is needed. Two flaps of skin as long as the web, and half the width of a finger, are respectively raised from the dorsal aspect of one finger and from the palmar aspect of the other, in such a manner that, after the web has been divided, the denuded surfaces can be covered by wrapping the flaps round the lateral aspects of the fingers and suturing them in position. An additional flap of skin must also be fixed in the angle between the separated digits, unless the preliminary measure just described has been undertaken.

**Congenital Contraction of the Fingers** is not a very rare deformity, it is frequently inherited, and usually limited to the little finger, it may be associated with congenital hammer-toe. It is due to contraction of the *central* prolongation of the palmar fascia in the finger, whereas in Dupuytren's contraction it is the palmar fascia itself and its *lateral* prolongations into the fingers that are involved. Moreover, the character of the deformity differs, in the congenital variety the first phalanx is hyper-extended, and the second and third flexed, whereas in the acquired form the first and second phalanges are flexed and the third is hyper-extended. **Treatment**—It often suffices to use massage and apply a splint, but in bad cases division of the fascial bands may be needed.

**Acquired Deformities of the Hand**—After burns the hand may be contracted into a useless mass in which the fingers are drawn into the palm and united by cicatricial tissue to the palmar structures, so that all treatment is hopeless.

**Spring-, Jerk-, or Snap-Finger** is a curious condition in which, when the patient attempts to open his hand, one finger or the thumb remains flexed, and on extending it with the other hand it flies open with a jerk or snap. Some slight tenderness and pain is usually felt near the metacarpo-phalangeal articulation, and the cause of the trouble is some obstruction to the free working of the long tendons under the transverse ligament at the root of the fingers, or between the sesamoid bones in the case of the thumb. In a few cases a ganglion has been present here, but in most instances it is due to an increase in size of the sesamoid bone which the X rays have taught us constantly occurs in this situation. Treatment consists in an aseptic incision to remove the cause of the obstruction.

A **Mallet Finger** is one in which the terminal phalanx is maintained in a state of flexion owing to some damage to the extensor aponeurosis. It usually follows injuries, which lead either to a separation of the tendon from the bone, or to a thinning of its texture, whereby the

flexor tendon is able to act with undue power. The **Treatment** consists in the application of an anterior finger-splint in the early stages, but later on, should the deformity be persistent, an incision is made on the posterior aspect of the joint, and the weak tendon isolated and stitched down in such a way as to give it a better attachment to the bone.

**Contraction of the Palmar Fascia (Dupuytren's Contraction)**—This condition is usually met with in middle-aged individuals of a gouty temperament, more often in men than women, and not unfrequently on both sides of the body. It may or may not be associated with direct irritation of the palm, as by leaning much on a round-headed cane, or from the constant use of some instrument, such as an awl, whilst heredity is an important causative factor. Pathologically, it is due to a chronic overgrowth and contraction of the fascia, inflammatory in nature, and cirrhotic or sclerosing in type. It commences

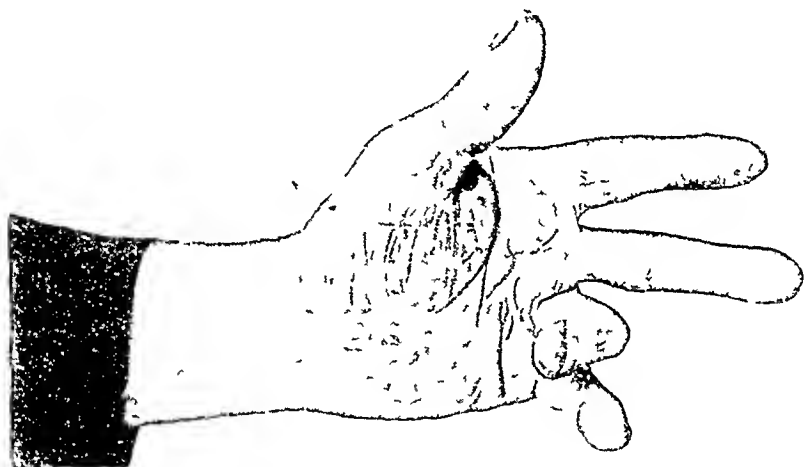


FIG 126 —DUPUYTREN'S CONTRACTION (FROM A PHOTOGRAPH)

as an indurated subcutaneous nodule in the palm of the hand, about the situation of the most marked transverse crease, and affects most commonly the ring and little fingers first, the other fingers and thumb being less often involved. The induration spreads slowly both up and down the fascial bands into the fingers, which, as it increases, are gradually drawn into the palm and fixed, so that extension becomes impossible (Fig 126). The flexion is limited to the first and second phalanges, the third remaining extended, and, indeed, sometimes assuming a position of hyper-extension, owing to the injudicious application of a splint. The skin over the indurated masses is sooner or later incorporated with them, and may become dimpled or creased by the traction of the subcutaneous connecting bands.

The **Diagnosis** of Dupuytren's contraction is exceedingly easy, the only condition for which it is likely to be mistaken being the congenital contraction already noted, and flexion of the finger due to contraction of the long tendons. In the latter case there is, as a rule, no palmar

induration, and on attempting to straighten the finger the tendons may be felt to become tense above the wrist, the terminal phalanx is also flexed in many instances

The only satisfactory **Treatment** is by operation, and the following methods are those which are most successful (a) Adams' subcutaneous section of the fascia and its prolongations consists in dividing the indurated bands by a tenotome in several places, where they can be felt tense. One puncture and division must be made in the centre of the palm, a second divides the same band as near the finger as possible, whilst the third and fourth deal with the lateral prolongations at the sides of the finger, if other bands still exist, they are treated similarly, the tenotome, if possible, in all cases being inserted between

the skin and the fascia. The improvement thus produced must be maintained and increased by the subsequent use of suitable apparatus and passive movements, but the final results are not very satisfactory (b) Kocher's method consists in the total extirpation of the thickened bands and their prolongations through longitudinal incisions. The fingers are at once straightened, and subsequent contraction is prevented by mechanical appliances. We have had many excellent and lasting cures by the latter operation

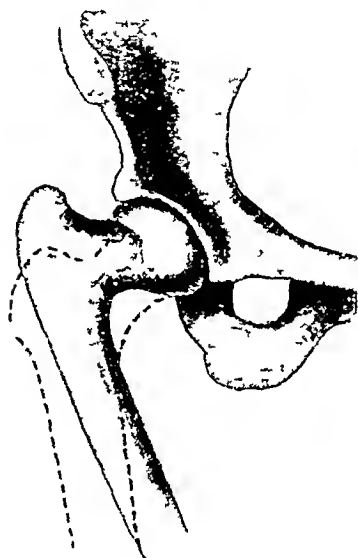


FIG 127 —COXA VARA

The dotted lines represent the normal neck of the femur

### Deformities of the Lower Extremity

**Coxa Vara**, or incurvation of the neck of the femur (Fig 127), is a condition to which attention has been called only of recent years. The neck of the bone, instead of passing obliquely upwards, is horizontal, or in bad cases directed

downwards and usually backwards, whilst shortening from interstitial absorption also occurs, and the head becomes mushroom-shaped (Plate V). At first the osseous tissue is softened, but after a while sclerosis supervenes. It is met with in young children as a result of rickets, or perhaps more frequently in adolescents, when it is sometimes supposed to be a late manifestation of the same disease. Certainly it is seen most frequently in those who have to do much walking or carrying of heavy weights. In some cases it results from a gradual slipping down of the epiphysis, which constitutes the head of the bone, or from a fracture of the neck in a child, followed by yielding of the callus.

The **Symptoms** commence with pain in the region of the hip, followed by a distinct limp. As the neck of the bone becomes absorbed or curved, the trochanter rises above Nélaton's line, and real shortening

PLATE V



SKIAGRAM OF DOUBLE CONA VARA





of the limb occurs, even up to  $1\frac{1}{2}$  inches. The limb is also everted and the trochanter increasingly prominent, especially on flexing the thighs. The movements of the joint are limited, particularly in the direction of internal rotation and abduction, the latter being practically impossible in the more severe cases, owing to the base of the trochanter hitching against the lip of the acetabulum. On flexing the limb, the thigh sometimes lies across the sound one, whilst in the later stages the adduction may be so marked that a scissor-legged condition occurs if both sides are affected. As distinguishing features may be mentioned the absence of local swelling or tenderness on pressure, as also of the up-and-down movement on traction, so well marked in congenital dislocation, whilst suppuration never follows, and thickening of the trochanter is not observed.

**Treatment**—In the early stages rest is the essential, and thereby any increase in the deformity already existing is prevented, local massage and manipulation are also advisable, whilst in children prolonged extension may do good. In the later stages, subtrochanteric osteotomy, in order to alter the axis of the bone, is perhaps the best measure to undertake, although a cuneiform osteotomy of the neck is recommended by some. The subsequent shortening may be dealt with by means of a thick sole on the under surface of the boot.

**Genu Valgum**, or *knock knee*, is a deformity in which, if the knees are allowed to touch with the patellæ looking forwards, the malleoli are separated one from the other—*i.e.*, it is a fixed condition of abduction of the legs from the middle line, with some external rotation (Fig 128). One or both limbs may be affected, but if due to general causes the double form is more common. Occasionally genu valgum occurs in one leg, whilst the other is in a condition of genu varum.

There are two main varieties of the disease, *viz.* (1) The rachitic genu valgum of young children, and (2) the static form occurring in adolescents.

The *genu valgum* of young children is practically always due to *rickets*,



FIG 128—GENU VALGUM OF RACHITIC ORIGIN

The patient was a child aged twelve years, and the cause of the deformity was rickets. The femora were curved antero-posteriorly, but skiagraphy demonstrated that the trouble in the right leg was as much tibial as femoral in origin. Cuneiform osteotomy of both tibia and femur was needed on the right side, whilst simple osteotomy of the femur sufficed to correct the left side.

owing to the irregular epiphyseal development induced thereby. In some cases there is a primary increased growth on the inner side, in others, an arrest of development on the outer, in the majority, both conditions are probably present. The location of the mischief, whether mainly femoral or tibial, also varies in different cases, but the femoral type is more common than the tibial. In some an antero-lateral rachitic curvature of the diaphysis of the femur is an important element, especially when the child has been allowed to walk or run about too early.

*The genu valgum of adolescents*, or static genu valgum, occurs most commonly in young people under twenty, of relaxed constitution, and particularly in those who, in addition, have to carry heavy weights. Thus, anæmic young women who act as nursemaids, and young bricklayers, smiths, and porters, are very liable to it. The method of origin is probably as follows. In the erect posture the femur is normally set at an angle to the tibia (which is vertical) in such a way that the weight of the trunk, transmitted in a vertical line from the head of the femur to the ground, passes rather through the outer than the inner condyle, whilst the latter structure is lengthened in order to keep the plane of the knee-joint horizontal. This position naturally throws a certain amount of strain and tension on the internal lateral ligament, even in a healthy person (hence its insertion into the shaft and not merely into the upper epiphysis of the tibia), and this strain is increased when the natural position of rest—*i.e.*, with the feet separated and slightly abducted—is adopted. A long continuance of this posture tires those muscles on the inner side of the limb which tend to counterbalance this strain, especially if a certain amount of additional weight has to be carried, and particularly in those whose bones have rapidly increased in length and weight without any coincident increase in power of muscles or ligaments. Hence the internal lateral ligament becomes more and more stretched, and not unfrequently a certain amount of lateral mobility of the knee is noticed in the early stages. Subsequently the outer condyle becomes atrophied from more weight being transmitted through it, and the inner condyle becomes lengthened from overgrowth. It is also important to note that flat-foot and lateral curvature of the spine often accompany this form of genu valgum, the former being also usually due to ligamentous relaxation, whilst the latter may be merely associated with it, or be compensatory if the deformity in the knee is unilateral.

Occasionally genu valgum is due to *traumatic causes*, such as fracture of the tibia or femur close to the joint, or lateral dislocation of the knee, whilst, again, it may be caused by atrophy consequent on interference with the epiphysis from local injury or diseases other than rickets. It is sometimes observed, as a result of riding, in those with long legs, as in cavalry soldiers, short-legged individuals, such as jockeys, are more liable to develop a condition of genu varum.

**The Physical Condition** of the parts about the knee may be summarized as follows

- (a) The inner condyle of the femur forms a marked and obvious

subcutaneous projection, the increase in size is mainly in the vertical and transverse directions, and but very little antero-posteriorly, so that, on flexion of the joint, the deformity to a large extent disappears.

(b) In rachitic cases a localized bony outgrowth can usually be detected on the inner surface of the tibia about 2 or 3 inches from the joint, and probably due to a localized periostitis at the point of attachment of the internal lateral ligament.

(c) Impaired growth and atrophy is observed in the outer femoral condyle and tibial tuberosity, conditions supposed to be due to the weight of the body being transmitted more directly through these structures.

(d) Relaxation of the ligamentous and muscular tissues takes place on the inner side of the joint. This, however, is not constant, especially in the later stages, or in cases which are stationary.

(e) The tendons and ligaments on the outer aspect of the joint are contracted and shortened, especially the external lateral ligament, the ilio-tibial band, and the tendon of the biceps.

(f) The patella tends to be thrown outwards from the angular deformity existing at the knee-joint. Occasionally the bone is actually dislocated, and when this has once happened the displacement is very likely to recur from time to time.

The following conditions are also observed not unfrequently, viz. The feet are displaced outwards, or occasionally inwards, as best suits the convenience of the patient in obtaining as good a footing as possible, the bones of the legs and of the thighs are often bent, whilst, if unilateral, the pelvis is tilted downwards on the affected side, and the spine laterally curved.

In well-marked cases the gait of the patient is of a rolling or waddling type, and very characteristic. The legs are partially flexed, and as the condyles touch or overlap, they have to be separated at each step to allow of progression. Occasionally bursæ form over the points where the friction is most marked.

**Treatment** — In *rachitic* infants, the general condition must be dealt with in accordance with the rules given elsewhere (p. 601). A suitable diet should be ordered, cleanliness attended to, and plenty of fresh air allowed. Parrish's food is perhaps the best drug to administer, whilst cod-liver oil is rarely needed, since it increases the body-weight, and so may do harm rather than good. Absolute rest in bed is enforced, the limbs are well rubbed daily, and such manipulation and pressure employed as will help to straighten the limb. By perseverance slow but appreciable progress may be made until the deformity is corrected. In older children, splints may be applied on the outer side of the limbs, reaching from the pelvis down to the outer malleoli, or, if they are to be kept off their feet, beyond them. These are retained in position by water-glass bandages, put on firmly enough to draw the knees outwards. Such an arrangement is often sufficient in early cases to bring about a cure in the course of a few months. Some authorities have recommended forcible correction of the deformity, and subsequent fixation in plaster of Paris, but the condition of the

epiphyses, and the ease with which they are detached, are good reasons against adopting any such method

In the *static* cases the administration of tonics, such as iron and arsenic, combined with rest, massage, and possibly a change of air, will frequently suffice to determine a cure in the early stages

When the deformity is somewhat more advanced, more complicated apparatus is needed, that usually employed consists of an outside iron stem, jointed at the knee, fixed below into a slot in the heel of a well-made boot, and attached above to a pelvic band. From it several well-padded straps pass round the limb, and at the knee itself a much broader one covers the projecting inner condyle, by tightening these, the limb is drawn out towards the rod. The apparatus is somewhat heavy, but if carefully applied for some months may effect a cure. It is possible that division of the tense structures on the outer side of the joint may considerably assist the process

When, however, the osseous deformity is marked, and the patient of such an age as to preclude the hope of a cure by mechanical means, *osteotomy* will be required, and the operation devised by *Macewen*, or some modification of it, is that generally employed. It consists in the division of the femur transversely about a finger's breadth above the upper border of the external condyle, so as to be well away from the epiphyseal cartilage. *Macewen* himself uses an osteotome\* for the purpose, introducing it through an incision made  $\frac{1}{2}$  inch in front of the tendon of the adductor magnus, and turning it so as to lie at right angles to the long axis of the shaft, he divides the bone for three-quarters of its diameter, and breaks the remainder. A similar method may be employed from the outer side, the force used in breaking the inner layer of compact bone comminuting and compressing that portion, and so diminishing the deformity. Many surgeons, however, prefer to divide the bone with a saw, previously making a track for it along the front of the femur, and we certainly consider that such an operation is simpler, and equally efficacious. The limb, having been straightened, is either put up at once in plaster of Paris, or, perhaps, at first in a *Gooch's* splint, which allows the wound to be looked at and dressed, and subsequently in plaster. Union is complete in six weeks, but an immovable apparatus should be kept on for three months.

In a few cases due to rickets it may be necessary to divide the tibia just below the tubercle in addition to dealing with the femur. This is best accomplished as a first step, and the fibula will also have to be divided. When these wounds have consolidated, the femur is dealt with, if necessary.

**Genu Varum**, or *bow leg*, is a less common condition, the exact opposite of genu valgum, and what has been said above of the one is true of the other, if the word 'internal' be substituted for 'external' and *vice versa*. Treatment is only required in bad cases.

**Genu Recurvatum**, or *back knee*, is a deformity occasionally met with in which the joint is hyper extended, the limb describing a curve with

\* An *osteotome* differs from a *chisel* in the fact that the former is bevelled on both sides, whilst the latter is merely bevelled on one side.

the concavity forwards, it is necessarily associated with relaxation or stretching of the crucial ligaments, and is usually due to a congenital displacement, possibly the result of the limbs not being flexed *in utero*, but extended with the feet under the chin. It is sometimes the result of paralysis of the flexor muscles of the knee and of the popliteus, or may arise from irregular growth along the epiphyseal line, possibly as a sequela of tuberculous or other disease of limited extent in that region. It has also been known to occur as an acquired accomplishment in fakirs and contortionists. If treatment is necessary, it must be suited to the special requirements of the individual case.

**Contractions of the Knee** may arise from intra- or extra-articular causes. The *extra-articular* causes may be situated (1) in the *skin* and subcutaneous tissues, as a result of the contraction of cicatrices of burns or ulcers, or (2) in the *flexor muscles*, which may become contracted in consequence of diffuse suppuration within their sheaths, or of infantile paralysis of the extensors, or as a secondary result of inflammatory troubles in the knee-joint. (3) The contraction is in some cases *hysterical*, the joint being fixed by muscular action, but remaining healthy, although much pain and superficial tenderness are complained of. The diagnosis is readily made by inducing anæsthesia, or taking the patient unawares, when the limb is found freely moveable and can be easily straightened.

The *articular* causes are as follows. (1) Where the capsule and ligaments are mainly affected, the causative inflammation having been of a rheumatic or gonorrhœal nature. The limb is fixed, but there is no actual displacement of the tibia. (2) Fibrous adhesions of greater or less density may pass between the articular surfaces, as a result either of acute synovitis or of tuberculous or acute arthritis. In the former case some mobility may be present, but in the latter the movements may be very defective. (3) Osseous ankylosis may follow tuberculous or acute arthritis, the position of the limb depending on the previous treatment. Thus, in neglected cases the tibia is occasionally flexed on the femur, whilst its upper surface is displaced horizontally backwards, and the lower limb rotated outwards, constituting what is known as the *triple displacement*. If the limb has been allowed to lie on its outer side whilst disorganization was proceeding, there may be an additional outward displacement of the tibia. (4) After partial excision in early life, the knee may become flexed or hyper-extended years later, as a result of irregular growth at the epiphyseal line. Flexion is much more common than extension.

The **Treatment** of these conditions necessarily depends on their nature. Where adhesions exist within the joint, or the ligaments alone are contracted, it may be possible to straighten the limb under an anæsthetic by forcible manipulation. Where the contraction is associated with osseous ankylosis, a suitable wedge shaped piece of bone should be removed (*cuneiform osteotomy*). In the triple displacement ordinary excision may be undertaken, but it is often a difficult matter to remedy the backward displacement of the tibia. The bones should subsequently be kept in position by silver-wire sutures, or other means.

**Rachitic Tibia and Fibula** — These bones are liable to a considerable amount of distortion in the course of an attack of rickets if the child is allowed to run about. As a rule, the antero-posterior curve is increased, and some amount of ab- or ad-duction may also be present (Fig 599). The bones, too, are usually flattened from side to side, presenting a sharp edge in front, with a buttress-like support reaching along the concavity, they become exceedingly dense and sclerosed. Operations should never be undertaken until all active signs of rickets have disappeared. The bones may simply be divided at their most prominent part, or, if necessary, a wedge-shaped portion may be removed from the tibia (*cuneiform osteotomy*), the sections being made at right angles to the upper and lower segments of the bone respectively. The fibula never needs more than simple division, and this is accomplished through a separate incision.

The tibia and fibula also become distorted and curved antero-posteriorly as the result of *inherited syphilis*. The deformity in this case is purely antero-posterior, without lateral deviation, whilst the subcutaneous margin of the tibia is rounded, and not sharp as in rickets. Moreover, the curve is mainly placed in the centre of the shaft, whilst in rickets the chief deformity occurs either near the knee or a little above the ankle. There should, therefore, be but little difficulty in distinguishing these two conditions, and the previous history of the case may materially assist in forming a correct diagnosis.

### Talipes

By talipes, or club-foot, is meant a deformity of the foot due to muscular, ligamentous, or osseous causes, the displacement occurring mainly at the ankle and mid-tarsal joints.

**Causes** — Talipes may be congenital or acquired.

**Congenital malformation or malposition** is responsible for a certain percentage of the cases. Such may result from imperfect development of the bones of the foot or leg, or from intra-uterine paralysis of central origin. Other cases may be due to a deficient amount of liquor amnii, as a result of which the feet are abnormally compressed and held in one position. It must be remembered in this connection that in the foetus the legs are naturally in a state of flexion, and the feet usually in the position corresponding to that of talipes varus, it is easy then to understand that in an unusually small uterus this tendency may be exaggerated. *Spina bifida* in the lumbār region is occasionally associated with congenital talipes, which is then probably due to impairment of nervous control. The congenital variety is often hereditary, and may occur in several members of the same family, or be transmitted through many generations.

The *acquired* varieties are somewhat easier to understand than the congenital, since they frequently arise from some derangement of the equilibrium normally maintained between opposing groups of muscles, in consequence of which the most powerful group draws the foot into an abnormal position. Thus it may be due to (a) Paralysis of

central origin, one of the commonest causes of talipes, in young children this form is usually the result of infantile palsy (anterior polio-myelitis), whilst a similar affection is occasionally seen in adults (b) Contraction of muscles, from diffuse suppuration, arising from burns or disease of neighbouring bones, thus necrosis or caries of the tibia may lead to the formation of an abscess in the sheaths of the *tibialis anticus* or *posticus*, and contraction of one or both of these muscles may cause talipes varus (c) Essential muscular shrinking, resulting from a chronic myositis fibrosa, is occasionally met with in elderly people (d) Affections of the main peripheral nerve-trunks of the leg also lead to talipes. If the internal popliteal nerve is involved, talipes calcaneo valgus will ensue, whilst a lesion of the external

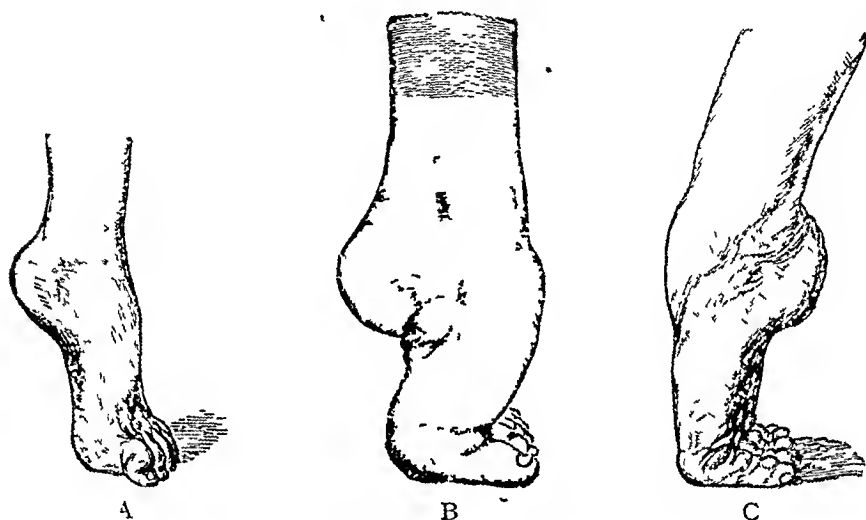


FIG 129—VARIOUS FORMS OF TALIPES EQUINUS

popliteal nerve produces talipes equino-varus, but never to any marked degree (e) Deep spinal mischief of a sclerosing type occasionally causes spasm of some group of muscles and talipes of a spastic type (f) Shortening of the leg from hip or knee mischief often induces a compensatory talipes equinus, whilst injuries or diseases of one of the epiphyses of the leg bones may stop its growth, and then the continued development of the other bone forces the foot to one side or the other (g) It is a question whether the condition known as flat-foot, arising from prolonged standing, is to be classed as a form of talipes, some surgeons draw but little difference between it and talipes valgus (h) Finally, prolonged maintenance of the foot in a bad position may lead to permanent deformity, as in the variety known as talipes decubitus. The barbarous custom still practised by the Chinese of forcibly compressing the feet of female children brings about a similar result.

**Varieties**—In considering the different forms of club-foot, it must be remembered that the ankle is a hinge joint only allowing of flexion and extension, although when fully plantar-flexed a little lateral



mobility is also possible. The movements of abduction and adduction of the foot take place at the subastragaloid and mid-tarsal articulations. Four primary varieties of talipes are hence described, viz **T Equinus**, in which the heel is drawn up, the patient walking on the toes (plantar-flexion), **T Calcaneus**, in which the toes are raised from the ground (dorsi-flexion), **T Varus**, in which the anterior half of the foot is adducted, and the inner side of the foot is raised, the patient walking on the outer, and **T Valgus**, due to abduction and eversion of the anterior half of the foot, or to yielding of the longitudinal arch on the inner side. Not unfrequently mixed forms occur, due to the association of two of the above, *e g*, **T equino-varus**, or **T equino valgus**, or **T calcaneo valgus**.

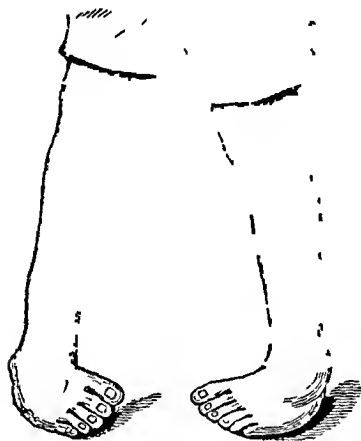


FIG 130 — CONGENITAL TALIPES  
VARUS



FIG 131 — PARALYTIC FORM OF  
TALIPES EQUINO-VARUS

As to the *relative frequency* of these different forms, there is not the slightest question that **T equino-varus** is by far the commonest. If, however, we exclude congenital cases and flat-foot, **T equinus** is in all probability the variety most frequently observed.

**Talipes Equinus** (Fig 129, A, B, and C) is almost always acquired, as a congenital lesion it is very uncommon. It is usually due to paralysis of the extensor muscles, either from infantile palsy or injury to the anterior tibial nerve, secondary contraction of the calf muscles follows, the tendo Achillis being tense and rigid. It also occurs as a compensatory manifestation where the limb has been shortened, as after hip disease, and a variety known as **T decubitus** results from prolonged pressure of the bed-clothes on the dorsum of the foot of a bed-ridden patient.

In the slightest cases all that is noticed is that the foot cannot be dorsi-flexed beyond a right angle (right-angled contraction of the ankle). When more marked, the heel is drawn up, and the patient walks on the heads of the metatarsal bones and on the toes, which are usually hyper-extended. In neglected cases due to paralysis, the toes sometimes become flexed, the patient walking on their upper surface.

(Fig 129, C), the whole dorsum of the foot may even in time be turned downwards. The astragalus is displaced forwards from under the malleolar arch, only the posterior part of the articular surface being in contact with the tibia. In the paralytic type the anterior segment of the foot drops at the mid-tarsal joint, so that the head of the astragalus and scaphoid constitute a marked prominence beneath the skin. In all cases the sole of the foot is shortened by contraction of the plantar fascia and of the short plantar muscles (*pes cavus*), and a certain amount of *varus* is frequently present. In this, as in all forms of *talipes*, *callosities*, and perhaps *bursæ* beneath them, form over points of pressure, viz, under the heads of *all* the metatarsal bones.

*Talipes Varus*, or, as it is most frequently termed, *Equino-varus*, is

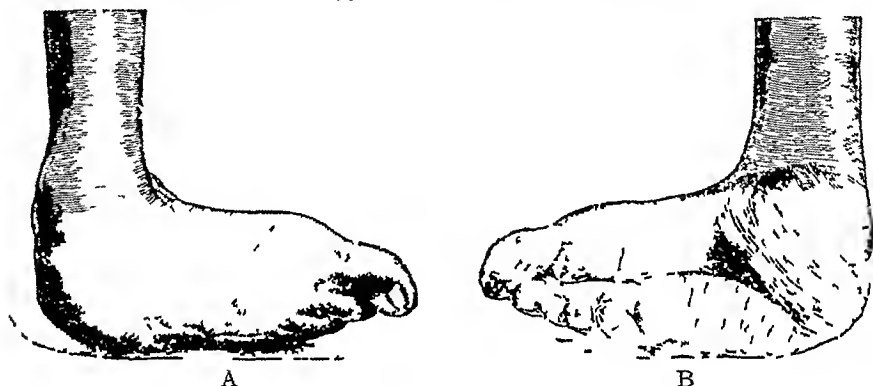


FIG. 132.—NEGLECTED CASE OF TALIPES VARUS

the commonest variety of congenital club-foot, but is not a very unusual result of infantile palsy of the extensor and peroneal muscles, with secondary shortening of the *tibialis anticus* and *posticus*, the *flexor longus digitorum*, and of the *tendo Achillis*. Other cases are due to a primary spastic contraction of these muscles.

The heel is drawn up, and the anterior half of the foot adducted and drawn inwards (Fig 130). The inner border of the foot is concave, and a well-marked transverse crease crosses the sole on a level with the mid tarsal joint, the outer border is convex, and in adults who have walked a thick bursal formation is usually present over the cuboid. In neglected cases the patient may even stand on the dorsal aspect of the latter bone (Fig 132, A). The sole of the foot is arched from secondary contraction of the plantar fascia and short muscles of the sole, especially the *abductor hallucis*, and a longitudinal crease may run down the centre of the sole, owing to doubling over of the outer metatarsal bones (Fig 132, B).

The most marked **Anatomical Changes** in the congenital type are found in the astragalus. In infants the head and neck are normally set at an angle to the body of the bone, being directed slightly inwards, as growth proceeds, this diminishes from about  $35^{\circ}$  to  $10^{\circ}$ , so that in the adult there is but little obliquity of the neck. In *Talipes varus* this angle is increased, often amounting to  $50^{\circ}$  or more, the neck at

the same time being longer than usual, a condition simulating that found in some of the higher apes. The bone also projects forwards from under the tibio-fibular arch, the posterior portion of the upper articular facet alone remaining in contact with it. The scaphoid is displaced to the inner side of the head of the astragalus, and its tubercle is usually in close proximity to, or may even touch, the inner malleolus. The os calcis and other tarsal bones are also modified in position and shape to correspond with these changes. The dorsal tendons are displaced inwards, usually occupying the centre of the concavity between the foot and the leg. The ligaments on the inner side of the foot are contracted, especially the anterior portion of the deltoid, the inferior calcaneo-scapoid, and to a less extent the long and short plantar ligaments.

The following table (slightly modified from Mr Tubby's work on Deformities\*) indicates the chief diagnostic points between congenital and paralytic T equino varus.

	CONGENITAL	PARALYTIC
HISTORY	Affection has existed from birth	Affection not developed till the second or third year, and ushered in by convulsions, fever etc
FEET AFFECTED	Usually bilateral	More often unilateral
CIRCULATION	Good	Feeble limb is cold, blue, and clammy
MUSCLES	But little wasting	Extreme wasting
ELECTRICAL REACTIONS	Not much impaired	Almost entirely absent in paralyzed muscles
GROWTH OF BONES	Much as usual	Considerably diminished
FURROWS IN SOLE	Present	Absent

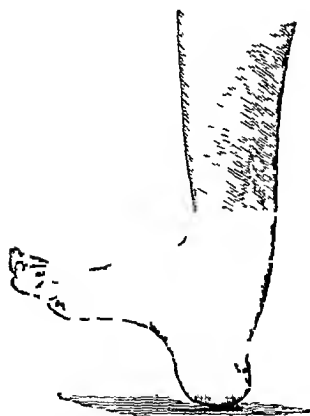


FIG 133 — PARALYTIC  
TALIPES CALCANEUS

**Talipes Calcaneus** (Fig 133) is an unusual variety of the deformity, and may be either congenital or acquired. In the *congenital* form the toes are drawn upwards so that the heel alone comes into contact with the ground, the sole pointing forwards. The extensor tendons are contracted, but the toes may be flexed owing to the tension of the flexor longus digitorum. It is sometimes associated with deviation of the foot inwards or outwards, constituting a condition of T calcaneo-varus or -valgus. The *acquired* variety is generally due to infantile palsy of the calf muscles, but occasionally results from over-stretching of the tendo Achillis after tenotomy. The longitudinal arch of the foot is increased, partly from the development of a large pad

of fat over the calcaneal tuberosities, but mainly from the toes not being drawn up towards the leg as in the preceding variety. The

\* Macmillan, 1896 p 398

anterior half of the foot appears to drop forwards from the mid-tarsal joint owing to secondary contraction of the plantar fascia and short muscles of the sole

**Talipes Valgus** is a condition seldom met with as a *congenital* deformity, except in association with *T equinus*. In it the outer side of the foot is abducted and everted, owing to contraction of the peronei muscles. The sole becomes flattened, and the inner border of the foot comes in contact with the ground (Fig 134). Considerable pain is usually experienced after walking a short distance. The scaphoid is displaced outwards, so that the inner portion of the head of the astragalus projects into the sole of the foot, the cartilage being uncovered. This deformity is occasionally due to absence of the fibula. The *acquired* variety, which is not uncommon (Fig 135), is produced as a result of paralysis of the tibial muscles, or from spastic



FIG 134 —TALIPES VALGUS (CONGENITAL),  
WITH A LITTLE TENDENCY TO CALCANEUS



FIG 135 —ACQUIRED TALIPES  
VALGUS

contraction of the peronei, the condition in these cases closely simulating flat-foot

The **Diagnosis** of the different varieties of talipes is, as a rule, easily made, although the cause of the deformity is not always so readily ascertained. In *paralytic* cases the limb is always atrophied, bluish in colour, and feels cold and clammy. Trophic lesions are not uncommon in the shape of recurrent ulceration, and even ulcers of the perforating type may develop, especially in cases due to nerve lesions, whether central or peripheral. The trouble is often unilateral, and the muscles are wasted and flabby. In *congenital* cases the condition is usually symmetrical, and of course present from birth, considerable resistance is felt on any attempt being made to correct the deformity, and the limbs are well nourished, at any rate at first. In *spastic* cases (most frequently *T equinus*) spasm or contraction of other parts is usually present, which renders the diagnosis obvious, one or both limbs may be affected, the muscles, at first firmly contracted, may finally atrophy.

The **Treatment** of talipes is always tedious, demanding care and patience on the part of all concerned. In the congenital variety no time should be lost in correcting the deformity, and, in fact, treatment

should commence as soon after birth as possible. The nurse must be instructed to manipulate the foot into a good position, holding it there for some time daily, and the medical attendant may attempt more forcible correction two or three times a week. At the same time the muscles on the offending side of the limb should be rubbed and stimulated. In the early stages of the paralytic variety friction and faradization of the paralyzed muscles must be regularly undertaken. At a somewhat later date treatment by the application of suitable mechanical apparatus may suffice to restore the foot to its normal position. If this is unsuccessful, division of the contracted tendons, ligaments, and fasciæ will be necessary, whilst in severe and neglected cases more extensive operations in the shape of tarsectomy or tarsotomy may have to be performed.

*Talipes equinus*, if secondary to hip disease, should not, as a rule, be interfered with. In other early cases, it may be remedied by what

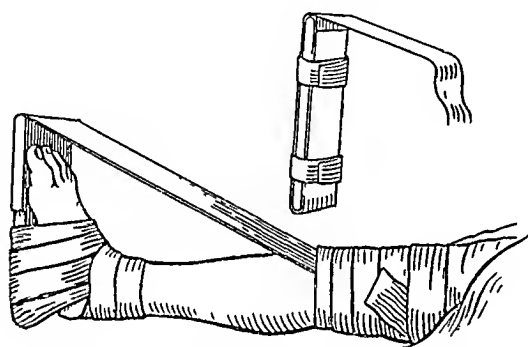


FIG 136 — SAYRE'S APPARATUS FOR TALIPES EQUINUS

The upper figure shows how the strapping is fixed to the plantar splint

is known as Sayre's apparatus (Fig 136). This consists in the application of a plantar splint which projects slightly beyond the toes, and from the anterior end of which a piece of adhesive strapping is carried to just below the knee, to which it is applied and fixed by a firm bandage. Each day the bandage is carried a little lower down the limb, and as the traction of the strapping is thereby increased, the foot is gradually extended. In the

more serious varieties tenotomy of the tendo Achillis may be required, accompanied, if necessary, by division of the plantar fascia, whilst in neglected cases, or where tenotomy has failed, excision of the astragalus gives most excellent results, the patient being able to walk subsequently with a plantigrade foot.

*Talipes equino-varus* may be treated in the early stages by applying to the foot a carefully-fitted malleable splint (Fig 137), the shape of which is gradually altered so as to bring it in time to a normal position, or by a series of casings of plaster of Paris, a little improvement being obtained at each change. By care and patience many a cure will thus be obtained. In some cases the tendo Achillis may be divided and the equinus element cured, thereby rendering the varus condition more amenable to pressure.

In cases where such early treatment has not been undertaken, or where the deformity has not been improved thereby, *forcible correction* (*redressement modelant*) may be attempted. The child is placed under an anæsthetic, and the foot is forcibly wrenched and moulded into a

good position, a Thomas's wrench being employed, if need be. It is essential that the foot should remain in good position when all force is removed from it. Possibly division of the tibial tendons may assist in this procedure, as also section of the tense ligaments on the inner side of the foot (syndesmotomy), but if such can be avoided, so much the better. The foot is then placed in plaster of Paris for five or six weeks, and subsequently massage and suitable exercises are employed before walking is allowed.

It is, however, only in the early stages that such treatment is advisable. At the age of eighteen to twenty-four months considerable growth of the limb has determined such osseous development as almost forbids one to expect benefit from it, since the force needed to correct the deformity would be very great. Hence, if treatment is not commenced till the child is two years of age, and still more if the child has walked or is older, other methods must be employed. Of these, two chief plans have been advocated, viz, tarsectomy and Phelps' operation. In *tarsectomy*, a wedge-shaped portion of bone is removed from the outer aspect of the foot. This is accomplished through a semi-lunar incision on the outer aspect of the foot, a flap being turned up so as to allow it to be shortened before the operation is completed, so that the skin being tense may help to keep the foot in good position. The thick subcutaneous structures, including the bursa, are removed, and the extensor tendons, already somewhat displaced inwards, are stripped from the bones by a raspator, and held aside by retractors. The tarsus is now divided by a chisel in two places in such a way that a wedge of bone can be removed, the base being on the outer aspect, and the apex on the inner. The position of the joints need not be taken much into consideration, and as far as possible the sections are made at right angles to the anterior and posterior segments of the foot respectively. As a rule, one removes the head of the astragalus and part of the greater process of the os calcis, sufficient bone must be excised to allow the foot to come into good position without difficulty. The wound is then closed, and the foot placed in a good position, in which it is maintained at first by ordinary splints and subsequently by plaster of Paris for six or eight weeks. The results are excellent,

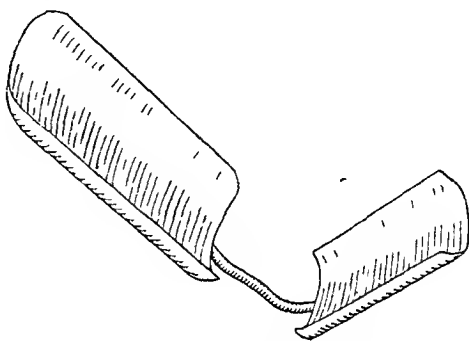


FIG. 137 — MALLEABLE SPLINT FOR TREATMENT OF CONGENITAL TALIPES EQUINO-VARUS

It consists of two plates of metal, shaped to fit the sole of the foot and the lower part of the leg respectively, these are united by a malleable curved bar of copper. The foot-piece is first fixed, and then the foot brought into as good a position as possible, and the leg-piece bandaged on. Each week the foot-piece is bent a little more towards the normal position.

The thick subcutaneous structures, including the bursa, are removed, and the extensor tendons, already somewhat displaced inwards, are stripped from the bones by a raspator, and held aside by retractors. The tarsus is now divided by a chisel in two places in such a way that a wedge of bone can be removed, the base being on the outer aspect, and the apex on the inner. The position of the joints need not be taken much into consideration, and as far as possible the sections are made at right angles to the anterior and posterior segments of the foot respectively. As a rule, one removes the head of the astragalus and part of the greater process of the os calcis, sufficient bone must be excised to allow the foot to come into good position without difficulty. The wound is then closed, and the foot placed in a good position, in which it is maintained at first by ordinary splints and subsequently by plaster of Paris for six or eight weeks. The results are excellent,

the foot, although a little shortened, being firm and plantigrade. 2 *Phelps' operation* consists in dividing all the structures on the inner aspect of the foot through a vertical incision, starting above just in front of the internal malleolus. The mid-tarsal joint is usually opened, tendons and ligaments are divided, and the foot put up in a good position with the wound gaping. Healing may be accelerated by skin grafting. The results are at first quite as good as those attained by tarsectomy, and the operation has the advantage of not shortening the foot, but there is a decided tendency for the deformity to recur as cicatrization advances. In successful cases the longitudinal arch of the foot is lost, and the cosmetic result is anything but perfect, whilst the patient usually requires an instep support. In our opinion tarsectomy is much the better operation, and even when undertaken in children need not interfere with the subsequent growth of the foot.

In *Talipes calcaneus* all that may be needed is division of the extensor tendons, but in the paralytic variety some form of apparatus must always be worn. Where the tendo Achillis is thin and attenuated, a portion of it may be excised, and the ends united by suture, or the healthy peroneus longus tendon may be grafted into the tendo Achillis, or the tubercle of the os calcis into which the latter is inserted may be sawn off and re-attached by a nail or peg to the bone at a lower level (Walsham), but the prognosis in all forms due to paralysis is somewhat unsatisfactory.

*Talipes valgus*, if unrelieved by the application of suitable boots, may need division of the peroneal tendons, or in severer cases wrenching the foot into position, and fixation in plaster of Paris. Removal of a wedge-shaped portion of bone from the inner aspect of the foot may be undertaken, but is not very successful.

**Flat-foot** (*syn* **Splay-foot** or **Spurious Valgus**) is a condition frequently seen in young adults whose occupation exposes them to long standing, over-fatigue, or the carrying of heavy weights, hence it is commonly met with in nurse-girls and shop-boys who have only recently left school, any general deterioration of the health also assisting in the production of the deformity. It occurs as a natural condition in many of the negro races, and is more often seen in long than in short feet. It also results from various osseous lesions, *e.g.*, fracture of the neck of the astragalus, of the sustentaculum tali, or of the greater process of the calcaneum (*traumatic flat-foot*).

**Mechanism** —In the majority of cases it is due to relaxation of the inferior calcaneo-scapoid ligament, which supports the under surface of the head of the astragalus, and thus keeps up the longitudinal arch of the foot. This in its turn is braced up by the tendon of the tibialis posticus and an expansion backwards therefrom to the os calcis, as also by the plantar fascia and ligaments, and by the short muscles of the sole. A rapid increase in the length and weight of the skeleton apart from an equivalent increase in strength of muscles and ligaments throws undue strain upon this structure, especially if the patient is suddenly exposed to long hours of standing or weight-carrying. The ligament stretches, the head of the astragalus sinks, the anterior

portion of the foot becomes abducted at the mid-tarsal joint, and the typical splay-foot results. The tibialis posticus is often relaxed or even parietic, and the peronei tendons are in the later stages contracted. Occasionally the deformity is due to a gonorrhoeal inflammation of the inferior calcaneo scaphoid ligament, which becomes relaxed and yields under the weight of the body. However produced the deformity is tolerably characteristic (Fig 138). The sole of the foot is flat, and in well-marked cases comes in contact with the ground throughout the whole of its extent. The inner border is convex and somewhat lengthened, whilst there is a tendency to eversion of its anterior portion. The outer border may be slightly raised from the ground. The head of the astragalus is distinctly felt a little



FIG 138 —FLAT-FOOT

in front of and below the internal malleolus, whilst the sustentaculum tali, which is normally to be distinguished about  $\frac{3}{4}$  inch below the malleolus, is buried by this displacement. The tubercle of the scaphoid is less evident than usual, being situated below and in front of the head of the astragalus. In the early stages the patient complains of a sensation of fatigue or weakness along the inner side of the foot or ankle, increased by exertion. Later on, the gait becomes somewhat shuffling, and severe pain is experienced, not only in the sole, but also on the dorsum over the astragalo scaphoid joint. Sometimes it is extremely marked in the metatarso phalangeal joint of the great toe, which may be enlarged and inflamed, owing to an associated chronic arthritis (*vide* Hallux rigidus).

**Treatment**—In the earliest stages, when the deformity, though threatening, has not yet actually developed, all that is required in many cases is rest, so as to allow the overstrained muscles and ligaments to recover themselves, at the same time the parts should be well rubbed with stimulating embrocations, and tonics administered to improve the general tone of the system. Square toed boots must be used, so as to check any tendency to a valgoid position of the foot, and in children the heels may sometimes be slightly thickened on the inner side. The patient must walk with the toes pointed forwards or



even inwards, and in some cases assistance may be obtained by ordering him to sit cross-kneed, in the tailor position, so as to exercise a certain amount of constant pressure inwards upon the front of the foot. Regular exercises ought to be instituted, such as raising the body on tiptoe with the feet inverted, such can only be undertaken for a short time at first, but as the muscles regain their tone a longer period can be tolerated. In a later stage elastic tension applied to the sunken arch is sometimes useful, Golding-Bird's sling can be employed for this purpose. It consists of a loop of soft webbing passed round the ankle and then under the instep, its free end being drawn up on the inner side and attached to an elastic accumulator which is connected with a steel garter-piece (Figs 139 and 140)

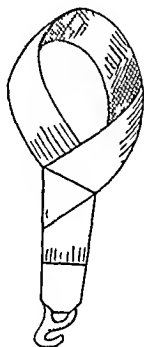


FIG 139 —MR GOLDING BIRD'S SLING OF SOFT WEBBING FOR SUPPORTING THE ARCH OF THE FOOT



FIG 140 —THE SLING APPLIED

In still worse cases a metal spring or instep pad may be required to support the foot whilst walking, but it must be remembered that it has no curative function, and indeed by its pressure tends still further to weaken the structures on the inner side of the foot. It must fit the instep accurately and be made to pattern for each particular case, extending from the root of the toes to the heel.

When the affection has reached a later stage, and the deformity cannot be remedied by ordinary manipulation, forcible-rectification under an anæsthetic may be employed. The foot is firmly grasped in the two hands or in a Thomas's wrench (Fig 141), and the anterior portion is forced inwards and backwards in such a way as to draw the scaphoid round the head of the astragalus as a fulcrum, and thus restore the arch. Probably a-number of adhesions in the astragalo-scapoid and other-joints will be felt to give way during this manipulation. Tenotomy of the peronei is sometimes required before rectification of the position is possible. The foot is then put up in plaster

of Paris and kept at rest for some weeks. Satisfactory results have followed.

In advanced cases that have been entirely neglected, operative proceedings may be necessary for the relief of pain, but they are not very satisfactory, and the after-treatment is troublesome and prolonged, so that if the patient can get on comfortably with an instep pad, it is perhaps wiser to make the best of this. Ogston advises the removal of a wedge of bone from the inner side of the neck of the astragalus, but others have recommended either removal of the scaphoid or of a wedge-shaped section of the foot without respect to joints (Stokes). In either case prolonged rest and a suitable course of exercises and massage will be required subsequently, whilst an instep pad may still have to be worn.

**Pes Cavus (Hollow or Claw Foot)** is a condition characterized by increased concavity of the plantar arch, so that when the individual

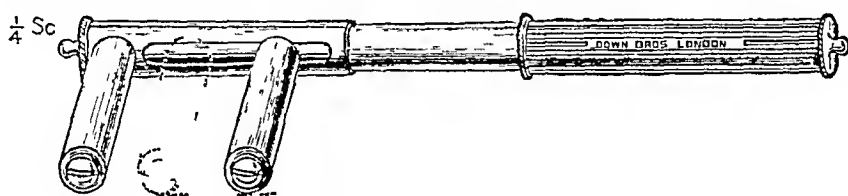


FIG 141 — THOMAS'S WRENCH (DOWN BROS.)

The two cross-bars are protected by thick india-rubber, and can be approximated or separated by rotation of the handle. The anterior portion of the foot is firmly grasped between them, one being placed on the dorsal and one on the plantar aspect, and forcible wrenching movements can then be carried out.

stands there is a greater interspace than usual, if not an absolute break, between the impressions produced by the anterior and posterior segments of the foot (Fig 129, B). It is almost always an acquired deformity, although a few cases of congenital cavus have been reported. Corresponding to the increased concavity in the sole, there is a marked convexity on the dorsal aspect of the foot, whilst the toes are generally in the condition to be immediately described as hammer-toe, the heads of the metatarsal bones are unduly prominent below, and callosities often form beneath them, causing considerable pain. The condition is almost always associated with a slight degree of talipes equinus (right-angled contraction), and its method of production from this cause is as follows. The weight is normally carried to the ground mainly through the heel, but also partly through the toes, in these cases it is only transmitted through the toes and front of the foot, and since the anterior extensor muscles are probably weak, the short flexors act at an advantage, and by contracting draw the heel downwards so as to reach the ground, and thus the arch is increased.

The **Treatment** in the early stages consists in friction applied to the weakened muscles of the leg, together, possibly, with the application of a splint to the sole. In more marked cases division of the tendo

Achillis is needed, together with subcutaneous section of the tense plantar fascia. The deformity of the toes usually disappears when the equinus is corrected, but may require further attention.

**Hallux Rigidus** (*syn* **H flexus**) is a painful condition of the great toe, due to a chronic arthritis of its metatarso-phalangeal articulation. It usually occurs in young males with flat feet. The foot is abnormally long, its circulation is defective, the toe itself may be in good position, but not unfrequently the first phalanx is flexed and the distal one hyper extended. It is probably due to abnormal pressure owing to the valgoid position of the foot, and possibly to wearing too short a boot.

**Treatment**—In the early stages correct the flat-foot, and see that suitable boots are worn. Failing this, careful strapping with Scott's dressing may give relief, but in bad cases excision of the head of the metatarsal may be required.

**Hallux Valgus**—This condition consists in a displacement outwards of the great toe from the median line of the body, as a result of which the other toes are huddled together, and in extreme cases the hallux is placed over or under them (Fig 142). It is present in the majority of people in some measure, owing to the usual shape in which boots are made, but in its severer forms it generally occurs in elderly people, and is often associated with a chronic arthritis of the metatarso-phalangeal joint of the hallux, the greater power of the adductor group of muscles explaining the deformity. The cartilaginous surface of the head of the first metatarsal bone becomes exposed beneath the skin, and by the constant irritation of the boot it becomes inflamed, its structure and shape altered, and the joint more or less disorganized.



FIG 142—HALLUX VALGUS  
WITH BUNION

Two other conditions are also met with arising from this deformity, viz, bunion and hammer toe.

A *bunion* consists in the formation of a bursa over the head of the first metatarsal bone, which becomes inflamed from cold or injury, and may even suppurate, the abscess usually communicating with the joint, and leading to its disorganization. A marked bony outgrowth is usually found under the bursa, springing from the inner side of the head of the bone, and due to a localized chronic periostitis.

The **Treatment** of hallux valgus in its earliest stages consists in the use of correctly shaped boots, with the inner border straight from toe to heel, whilst the sock or stocking should have a separate compartment for the great toe. The introduction of a toe-post between the great toe and its neighbour is sometimes effective in giving relief. In more severe types excision of the projecting head of the

metatarsal bone gives admirable results. The operation is best conducted by turning up a flap of skin and subcutaneous tissues over the inner aspect of the head of the metatarsal with its convexity forwards. The bone is then divided by a chisel and the head removed, allowing the toe to be easily replaced in a normal position. The skin is then laid down in place, and if need be shortened to meet the requirements of the case. Very rarely ought the second toe to be removed for this condition, as the lateral support of the great toe is thus weakened, and the deformity is probably aggravated. An *inflamed bunion* is treated by removing all local pressure, and applying fomentations. If the joint is involved in suppurative disease, excision of the head of the bone, or amputation of the toe, may be required. In less serious cases it may suffice merely to remove the thickened bursa.

**Hammer-toe**—This deformity is constituted by hyper-extension of the first phalanx, marked flexion to an acute angle of the second, and either flexion or extension of the terminal phalanx, so that the first interphalangeal joint projects under the upper leather of the boot, whilst the patient walks on the extremity of the ungual phalanx, or even on the nail (Fig 143). Corns form upon the points of pressure (1, 2, and 3), especially on the dorsal aspect, and a subcutaneous bursa over the head of the first phalanx (4), giving rise to great pain and inconvenience. The second toe is that most frequently affected, with or without the others, but it is uncommon for the hallux to be thus deformed.

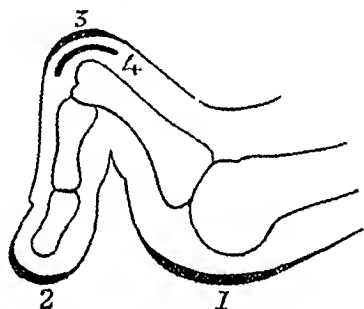


FIG 143.—HAMMER-TOE (AFTER KEEN AND WHITE)

- 1, Callosity over head of metatarsal bone in sole. 2, callosity over end of toe, 3, callosity on corn over head of first phalanx, 4, adventitious bursa over the same bony point

The **Causes** are numerous. It is occasionally congenital, but more often acquired, and then (a) it may be secondary to hallux valgus (b) it may result from wearing short and pointed boots, or very high heels, in either case the toes are crowded together and drawn up out of the way of pressure, (c) it follows contraction of the plantar fascia, and is then associated with pes cavus and talipes equinus (d) paralysis of the interossei and lumbricales may also lead to this condition in the same way that the *main en-griffe* follows ulnar paralysis.

However caused, the hyper-extension of the first phalanx is associated with a contracted state of the extensor tendons, which stand out very evidently beneath the skin. The flexion of the second phalanx on the first is carried to such a degree that the former bone is semi-dislocated. The prolongations of the plantar fascia on either side are much shortened, and the lower portions of the lateral ligaments of these articulations are also contracted.

**Treatment** may be commenced by the use of correctly-shaped boots, but the case has usually progressed to such an extent when the patient is first seen that no palliative measures are of any avail. Operation is then necessary, and probably the second phalanx is so much displaced that nothing short of removal of the head of the first phalanx holds out any prospect of permanent relief. An incision is made longitudinally over the joint, the extensor tendon being split down the middle, the head of the bone is then cleared by the raspator, and nipped off by cutting pliers. No splint is required, as the pressure of the dressings suffices to keep the toes in good position. Sometimes there is but little room between the great and third toes, so that even if one corrected the deformity of the second toe there is no space for it to lie comfortably, amputation should then be performed.

**Metatarsalgia**, or **Morton's Disease**, is characterized by severe pain of a neuralgic type located primarily about the head of one or more of the metatarsal bones, usually the fourth, but also radiating thence up and down the limb. It often occurs in gouty or rheumatic subjects, and may be attributed to some injury, a slight degree of flat-foot and the wearing of tight boots certainly predispose to it. It is probably due to compression of the digital nerves between the heads of the metatarsal bones and the ground. The foot is found to be broader than usual, and the anterior transverse arch formed by the heads of the metatarsals flattened out. Marked callosities or corns are observed on the under surface close to the heads of the bones, one or more of which may be unduly prominent. In a few cases small bony enlargements have projected from the heads of the metatarsal bones, and in others definite fibrous growths have been found in the subcutaneous tissues, in other cases a simple peripheral neuritis may explain the manifestations. The pain is generally induced by walking, and comes on in characteristic paroxysms. Lateral pressure over the metatarsal bones sometimes relieves the pain. Occasionally evidences of osteo-arthritis are manifested in one of the neighbouring joints.

**Treatment** consists in resting the foot, whilst suitable diet and drugs are ordered to combat any gouty or rheumatic tendency. At the end of a few weeks the patient may be allowed to walk again with boots, which are broad anteriorly, and fitted with an instep pad if necessary. Morton's recommendation—viz, excision of the head of the metatarsal bone—may be reserved for the more aggravated and serious forms.

## CHAPTER XIX

### INJURIES OF BONES—FRACTURES

**Contusion of a Bone** and of its periosteum is usually a matter of no great moment, although the part becomes painful and swollen. Occasionally a subacute periostitis is caused in people liable to rheumatism or gout, or in the subjects of syphilis, whilst in those who are thoroughly out of health, and with low germicidal power, acute infective periostitis or osteo-myelitis, resulting in necrosis, may supervene. The **Treatment** of an uncomplicated case consists merely in the use of cooling lotions or of a bandage, whilst if periosteal thickening results, iodide of potassium may be given, and iodine paint applied locally.

**Bending of Bone** may or may not be associated with fracture. Bending without fracture occurs mainly in children, and in adults is only the result of some local disease. More commonly a partial or green-stick fracture is produced (p 459), and in this the deformity can generally be corrected without much difficulty.

#### Fractures

A fracture may be defined as a sudden solution of continuity in a bone, usually resulting from external violence.

**Predisposing Causes of Fracture** — *Age* has a considerable influence in the determination of fractures for two reasons: firstly, because the strength and elasticity of bones vary considerably at different periods of life, and, secondly, because the exposure to injury is likewise variable. From two to four fractures are not uncommon, owing to the unsteady gait and frequent falls to which little children are liable, from four to six they are less common, the bones often bending so as to cause green-stick fractures, whilst injuries near joints induce separation of epiphyses, from six years onwards fractures are frequent enough, and increase steadily with age, old people being peculiarly liable to this form of accident, owing to the brittleness of their bones.

*Sex* — As might be expected, fractures are more common in the male sex during boyhood and adult life, but up to the age of four or five they are equally frequent in the two sexes, whilst after forty-five they are more common in women, owing to their great liability to intracapsular fracture of the cervix femoris and to Colles's fracture.

*Morbid Conditions of the Bones* predispose to fracture in a marked manner, often leading to what is known as *Spontaneous Fracture*, in which the determining force cannot be recognised or is very slight. Under this heading may be included (1) *Atrophy of bone*, from whatever cause it arises. Thus, it may be of the *senile* type, as manifested especially in the *cervix femoris*, or it may be due to want of use, as in a paralyzed limb or from an ankylosed joint. (2) Patients afflicted with certain mental or nervous diseases, such as general paralysis or *tabes dorsalis*, are unduly liable to fracture, which may result from atrophy, but may also occur in apparently healthy bones. Thus a man suffering from *tabes* was sitting with his thigh abducted and everted in order that he might examine and dress a perforating ulcer on the sole of the foot, when the shaft of the femur, subsequently shown to be of normal dimensions, and apparently of normal density, snapped in two. (3) *Fragilitas ossium* or *osteopathysosis* consists in an inherited tendency to spontaneous fracture. It results in a multiplicity of fractures, occurring even in children, thus, a girl, aged twelve and a half years, had suffered from forty one fractures since the second year of life. No explanation of this condition is known, the lesions often unite perfectly, though sometimes with a good deal of deformity. (4) *General bone diseases*, such as rickets and *osteomalacia*, also predispose to fracture, in those due to the latter affection there is usually but little attempt at repair. (5) *Local bone disease* may also constitute an important predisposing factor by weakening its structure. Thus, *sarcoma* and *secondary cancer of bone* are often first recognised by causing a spontaneous fracture, whilst manipulation of a limb which is the seat of *caries* or *necrosis* may lead to a similar result.

The *Exciting Causes of Fracture* are threefold. (1) *Direct violence*, the fracture occurring at the spot struck, and being often *transverse*, not unfrequently comminuted, and sometimes complicated with injuries to the adjacent soft parts. (2) When due to *indirect violence*, the bone gives way at a distance from the point to which the force is applied. The accident is usually produced by the compression or *bending of the bone* with such force as to exceed the limits of its natural elasticity, so that it yields at the weakest spot. Thus, when a person jumps from a height, the leg bones are compressed between the weight of the body and the resistance of the ground, and, if the violence is excessive, a fracture occurs at some point of mechanical disadvantage, it is often *oblique*, and when the displacement is considerable, it may become *compound*. When the violence is of a rotary character, as well as longitudinal, the fracture is likely to be of a *spiral type*. (3) *Muscular action* is most commonly the cause of fracture of small bones or of osseous prominences, into which powerful muscles are inserted. The *patella* and *olecranon* are not unfrequently broken in this way, the former often occurring from sudden and vigorous efforts to avert a fall. Occasionally one of the long bones, such as the *humerus* or *clavicle*, has been broken by violent muscular exertion, as by throwing a cricket-ball.

**Intra-uterine Fractures** are caused by blows upon the mother's abdomen, or by abnormal or violent uterine contractions, especially if the liquor amni is deficient in amount. They are usually followed by considerable deformity, which must be clearly distinguished from malformations resulting from imperfect development.

**Congenital Fractures** are produced during birth by violence used by the accouchéur, or from excessive uterine contractions. The femora are most likely to break in consequence of undue traction, the skull from injudicious pressure of forceps.

**Varieties**—A **Simple Fracture** is one in which the skin is unbroken, or, at any rate, where the external air has no admission to the site of injury. A **Compound Fracture** is present when the skin or mucous membrane is so lacerated that there is direct or indirect communication between the fracture and the external air. In the base of the skull, a fracture may open up one of the deeper air-sinuses, and thus it becomes compound without any apparent external lesion. These terms, though sanctioned by the approval of centuries, are neither of them good, *subcutaneous* and *open* being preferable. A subcutaneous fracture is often anything but a simple injury, and may result in the most disastrous consequences, whilst an open fracture may be a matter of comparatively little importance. Indeed, with our present appliances and methods of treatment open fractures often give better results than those that are called simple.

Fractures are complete or incomplete, according to whether or not the continuity of the bone is entirely interrupted. Various forms of **Incomplete Fracture** are described, and indeed the introduction of skiagraphy has shown that they are much more common than was formerly supposed. A *green-stick fracture* is one which only occurs in young children, and most often in those that are rickety, curved bones, such as the clavicle, are usually affected, and the fracture merely involves the convexity of the curve, whilst the concave half is bent, just as when a green bough or twig is partially broken. *Depressions* of the skull may be similarly incomplete when the outer table is driven in without fracture and the inner table alone splintered. *Fissured fractures* also are often only partial.

**Complete Fractures** may be *transverse*, though this is not very common, *oblique*, arising usually from indirect violence, *spiral*, when the force acts in a rotary direction as well as longitudinally, it occurs most frequently in the tibia or femur, and the lower fragment often has a sharp triangular upper end, giving it somewhat the appearance of the mouthpiece of a clarinet (fracture *en bec de flûte*, see Plate VI). A *longitudinal* fracture is one due to fissuring or splitting of the bone in its long axis, it is most common in military surgery, as the result of gunshot injuries, the neighbouring joints may or may not be involved. If it is combined with a transverse fissure, it is often termed T-shaped. *Comminuted* is a term used to describe the condition when the bone is broken into more than two pieces, *impacted*, when one fragment is driven into the other, *multiple*, when more than one fracture exists, *complicated*, when important structures, such as an artery or joint, are damaged as well as the bone.



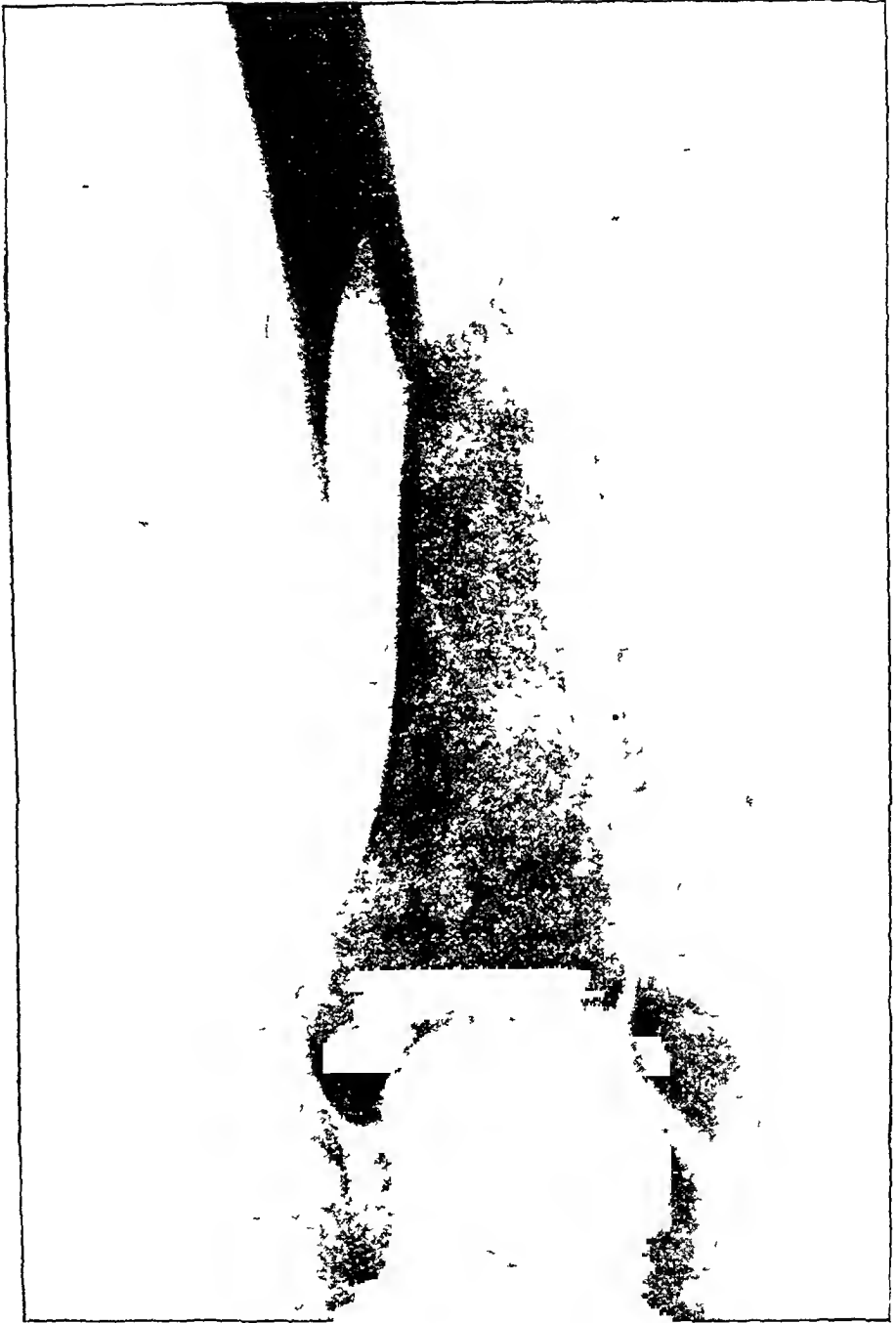
The **Separation of an Epiphysis** is not an uncommon occurrence in people under twenty-two years of age. It results from injury or violence directed to the ends of the bones, but occasionally is more or less spontaneous, or predisposed to by disease of the epiphysis or of the adjacent portion of the diaphysis (e.g., from inherited syphilis, acute infective osteo-myelitis, or tuberculous epiphysitis). The ends of the femur, humerus, or radius are those most often affected. The line of cleavage usually runs through the soft spongy bone on the diaphyseal side of the cartilage, so that there is cartilage with spicules of bone on one side, and spongy bone on the other. The direction taken is in the main transverse, but varies somewhat with the particular epiphysis. In very young children, where the epiphysis is entirely or mainly cartilaginous, the lesion is almost always a pure separation of the epiphysis from the shaft, but at a later date it not unusually extends in part through the adjacent end of the diaphysis (Fig 166). A very marked feature in all these lesions is the stripping up of the periosteum, which, though loosely attached to the shaft and easily separated from it in children, is firmly adherent to the cartilage, and hence retains its connection with it, thus frequently limiting displacement. If, however, the force is sufficient, the periosteum is torn through on one side by the edge of the bone, and the periosteal 'sleeve' which thus invests it may to some extent hinder reduction. The displacement is mainly lateral, and may somewhat resemble that of a dislocation. Union usually occurs by means of bone, and arrest of the longitudinal growth may follow, though not so frequently as was at one time supposed, and probably only when the parts are not in exact apposition. This is a matter of special importance where one of the bones of the leg or forearm is affected, since deformity of the hand or foot will result if the injured bone ceases to grow and the uninjured one continues its development. Suppuration sometimes occurs as a sequela in unhealthy children, or when the accident is due to preceding disease of the epiphysis, and may result in an acute arthritis, possibly necessitating amputation.

Partial detachment of an epiphysis (the *juxta-epiphyseal strain* of Ollier) often occurs, giving rise to phenomena similar to those of a sprain, if overlooked and neglected, it is likely to prove a fertile source of tuberculous disease, or may interfere with the growth of the limb. The essential feature is a more or less tender, but very distinct swelling of the bone close to the epiphysis, but the neighbouring joint remains unaffected. Treatment consists in immobilization in plaster of Paris.

**Signs of Fracture.**—The history usually given by the patient is that, as the result of some accident, he felt, or perhaps heard, something give way with a snap, and experienced sharp pain which became much intensified on attempting to move the limb. On examining the injured part and contrasting it with the opposite side, the following points are usually noticed

- 1 The *signs of a local trauma*, viz, pain, bruising, and swelling, as a

PLATE VI



OBLIQUE FRACTURE OF TIBIA SHOWING THE ENDS OF THE FRAGMENTS SHAPED  
*en bec de flute*

The skiagram was taken from the front through a casing of plaster of Paris, the  
*irregular outline of which can be seen on the inner side of the limb*



result of the effusion of blood from the torn and lacerated structures. The amount of this may be so great as to obliterate all the ordinary bony prominences and landmarks. Blebs and bullæ sometimes form over the surface in the course of a day or two, and these should be carefully protected from infection. The discoloration continues for some time, and may spread to parts far removed from the original mischief. This infiltration of the parts with blood often leads to considerable subsequent thickening, and possibly to serious adhesions and limitation of movement, this fact is correctly utilized as an argument in favour of the treatment of fractures by an open operation. It is unusual for suppuration to occur after a simple fracture, unless the patient is very debilitated and with diminished germicidal powers.

2 *Prieter-natural mobility in the continuity of the bone* may be demonstrated by manipulation, but never unnecessarily. Impaction or non-separation of the fragments prevents its occurrence.

3 Partial or complete *loss of function* also follows.

4 *Crepitus* is obtained by moving the limb and rubbing the rough ends against one another. It can only be felt when the fragments are moveable and can be brought into contact, but not when there is wide separation or impaction. When an epiphysis has been detached, it is softer in character.

5 Change in shape of the limb or *deformity from displacement* is almost always present. There are three chief factors at work in producing deformity, viz., the direction of the violence, the weight of the limb, and the contraction of muscles, whilst injudicious movement or rough handling may aggravate it. It is always more marked in oblique than in transverse fractures, and hence is usually greater in those due to indirect violence. Various types of displacement are described, viz. *Angular*, generally due to an increased curvature of the bone from the unbalanced action of powerful muscles, especially when the line of fracture is not far from the end of the shaft, as in fracture of the upper third of the thigh, *lateral*, where the displacement is merely to one or the other side, and most common in transverse fractures, *longitudinal*, when one fragment overlaps the other or is forcibly driven into it, causing shortening of the limb, it may also occur in the form of wide separation of the fragments, as from contraction of the quadriceps in fracture of the patella, *rotatory*, when one fragment is twisted on the other, as in fractures of the femur, where the weight of the limb causes eversion of the lower end. In flat bones—e.g., the skull—deformity may exist in the shape of *depression* or *elevation*.

Such are the typical signs of a fracture, but it goes without saying that all of them are not present in every case, and that it is not always easy to ascertain the existence or not of such a lesion. Comparison with the opposite limb, and gentle manipulation to demonstrate abnormal mobility or crepitus, must be undertaken to settle this point, but no undue violence should be used. The X rays have proved of the greatest value in these cases, and where there is any

doubt as to the existence or not of a fracture, the limb should at once be skiagraphed

**General or Constitutional Effects** — *Shock* is greater or less according to the amount of violence and the seat of injury. It varies from a mere passing faintness to the severest prostration. If the bones of the head or spine are injured, special symptoms due to concussion of the brain or injury to the spinal cord may also be produced.

*Hæmorrhage* is rarely sufficient to give rise to general effects unless the fracture is compound, and involves some important vessel.

*Fracture-fever* is met with in the majority of cases, commencing twenty-four hours after the accident and lasting two or three days. As a rule, it is not severe, the temperature rarely rising above 100° F in uncomplicated cases. It is a form of aseptic traumatic fever, probably due to the absorption of fibrin ferment. In compound fractures where asepsis is not attained, any form of wound infection may result, and even general septicæmia or pyæmia.

*Delirium tremens* is a not unusual complication of fractures of the leg in debilitated individuals or habitual drinkers. The general characters and treatment of the disease are dealt with elsewhere (p. 259). As regards local treatment, the limb must be fixed by splints or encased in plaster of Paris, and suspended in a Salter's swing so as to prevent the patient from moving the upper fragment independently of the lower.

*Fat embolism* results from the absorption of broken-up fat globules after any injury which causes contusion or laceration of fatty tissue, when this is accompanied by tension from effusion of blood, as in fractures, this process is more likely to occur. As a general rule, no harm results, since the great mass of the fat is filtered off by the lungs or eliminated by the kidneys (as can be demonstrated after death by staining with osmic acid). The pulmonary obstruction may, however, become so great as to lead to a fatal issue from dyspnoea, whilst if the cerebral vessels are also blocked, syncope, or even coma, may be induced. The symptoms, which are gradual in their onset, usually commence about the third day, but may not be evident for a week or more.

**Complicated Fractures** — 1 **Comminution** of one or both fragments is due to excessive violence, or perhaps to exceptional brittleness of the bones. As long as the skin remains unbroken, sound union is usually obtained, though with an increased amount of callus. Occasionally comminution may be a cause of non-union, a small detached portion of dense compact tissue being wedged crosswise between the fragments, especially in the case of the tibia or femur. In a compound fracture necrosis of the fragments may result from the admission of sepsis.

2 **Fracture implicating a Joint** — In healthy individuals no untoward result is met with; the joint is for the time filled with blood, which, however, is soon absorbed, and the fissure in the cartilage closed by plastic lymph. Adhesions may, however, form, as also new bony deposits, leading to defective mobility or even locking the

joint If the patient has a tuberculous tendency, arthritis will possibly be lighted up, whilst osteo arthritis is often induced by an accident of this nature

3 The same violence that causes the fracture may at the same time produce a **Dislocation** in a neighbouring joint Treatment should be undertaken immediately, the limb is firmly fixed in splints commanding both fragments, and reduction attempted under chloroform Failing this, consolidation must be allowed to proceed, and then the case dealt with as one of old-standing dislocation (p 620) ~~If the fracture involves, or is close to, the articular end of the bone,~~ as is not unfrequent at the elbow and shoulder, it is advisable to operate at once, opening the joint, reducing the dislocation, and fixing the fragments, or it may be better to remove the small detached articular portion

4 The **Main Artery** of a limb may be compressed, contused, punctured, or ruptured Thrombosis results, with or without such an extravasation of blood as may impede the venous return If the peripheral vessels are healthy, no permanent harm need follow, unless the vein is also implicated, and then moist gangrene is likely to supervene If the terminal vessels are calcareous and rigid, so that there has been a preceding condition of chronic anæmia, dry gangrene will probably ensue In the slighter cases an aneurism may subsequently develop For further details, see Chapters VI and XII The **Treatment** must necessarily vary in different cases The ideal practice would be to cut down in every case where a large artery is punctured or ruptured, remove clots, and tie above and below the injury in the vessel, but, owing to the difficulty sometimes experienced in securing aseptic conditions, it is not always advisable to do so, since the lacerated tissues are very prone to infection Under such circumstances the main artery may be compressed or tied above the fracture, but only when the distal circulation has been re-established, in the absence of this condition, gangrene would be certain to ensue If neither of the above-mentioned expedients can be adopted, an expectant plan of treatment must be followed The limb is thoroughly purified, wrapped in aseptic wool, placed on appropriate splints, and slightly elevated Should gangrene supervene, amputation is the only resource, it need not be undertaken for a few days if the limb is aseptic, so as to allow a distinct line of separation to form, but if septic, early removal through or above the line of fracture is essential

5 Laceration of **Veins** results in extravasation of blood, which is not so extensive as when an artery is wounded, since thrombosis occurs more easily, the distal part of the limb may become congested and œdematous, and this may constitute an additional element predisposing to gangrene Simple compression of the veins produces œdema, which, even in favourable cases, may persist for some time, needing for its removal firm bandaging, massage, and cold douching

6 The **Nerves** of a limb may be injured at two different periods  
(a) Immediate injury is due to laceration or rupture, either of the

whole trunk, or, as is more common, of the nerve fibrillæ, without loss of continuity of the sheath Paralytic and anæsthetic phenomena follow, but are usually recovered from (b) Secondary symptoms result from inclusion and compression of the nerve in the callus, or from injudicious splint pressure Irritative symptoms in the shape of neuralgia and muscular spasms are first manifested, followed by paralysis and anæsthesia This usually occurs about three or four weeks after the accident, and may disappear in a month or two, or persist **Treatment** is always for a time of the expectant type, even when the paralysis is immediate, since total rupture of a nerve is rare, and restoration of function the rule rather than the exception When, however, the symptoms persist, the parts must be laid open, the nerve freed from adhesions, or exuberant callus removed, and such measures taken as will best secure the nerve from further compression

The Union of Fractures is brought about by a series of changes analogous to those which we have already seen occur in other wounds, except that they do not terminate in the formation of cicatricial tissue, but go on to the further development of bone -

When a fracture has occurred, the broken ends of the bone are left rough, spiculated, and more or less separated one from the other, the periosteum is torn, but, according to Ollier, the rupture is not always complete all round, a 'periosteal bridge' perhaps persisting and playing an important part in the reparative process, especially if the fracture is not accurately set The muscles and neighbouring tissues are also lacerated, and a varying amount of blood is extravasated, occupying the interstices of the wound In the course of a few hours after the parts have been immobilized, the process of repair is inaugurated by the blood-clot becoming invaded by leucocytes, and after a time it is absorbed, the hæmoglobin passing through various stages of degeneration, and thereby staining the surrounding tissues At the same time, a rarefying inflammation occurs in all the injured and lacerated structures, as a result of which there is an exudation of plasma into their substance, whilst the connective-tissue cells proliferate actively Thus around and between the lacerated tissues and broken ends of the bone a cellulo plastic exudation forms, which is soon converted into granulation tissue, and inasmuch as the constituent cells are derived from bone, they early manifest a bone-forming or osteoblastic function Hence the continuity of the bone is restored by the formation around and between the broken ends of a mass of bone, which, at first soft and spongy, becomes after a time firm and sclerosed, whilst any unnecessary excess is subsequently absorbed Of course, these changes do not occur simultaneously in all the tissues involved, and we must refer to them as they affect the periosteum, the medulla, and the bony substance itself

The periosteum becomes thickened and more vascular, and its connection with the bone is loosened for a short distance by an

exudation of plasma, which is soon followed by a new deposit of spongy bone on the surface, as a result of the irritation. The space beneath the periosteum is quickly occupied by granulation tissue, which unites with that developed from surrounding torn structures and with that coming from the bone itself, and this ovoid mass binding the fractured ends together is known as the *provisional*-or *ensheathing callus*. The transformation of this callus into bone starts from the periosteum, if it has been totally lacerated, ossification commences at the furthest point from the fracture where the irritation caused thereby is felt, and gradually spreads in. If a periosteal bridge is left, ossification commences on its under surface, and not unfrequently in skiagrams a line of newly-formed bone can be seen passing from one fragment to the other, and evidently due to this cause. Some authorities maintain that new bone derived from periosteum in this manner is always preceded by cartilage, but this is probably not the case, although the presence of cartilage in the repair of fractures is more common than was formerly supposed. It is most likely to occur in cases where absolute immobilization has not been obtained—e.g., after fractures of the ribs and in children.

The medulla becomes hyperæmic for some distance from the seat of fracture and is transformed into granulation tissue, which unites with that springing up from the opposite fractured surface. Ossification commences from the inner aspect of the compact shell, from which fine spicules of bone gradually permeate the granulation mass until the whole is ossified, constituting the *internal-callus*, or, better, the *medullary plug*. There is here no formation of cartilage.

Naturally, the compact bony tissue is the last to engage in these changes, and the denser the bone, the longer they are in being completed. The fractured ends become hyperæmic and rarefied, the bone cells proliferating, the medullary contents of the Haversian canals increasing in amount, and the actual osseous substance being absorbed, until the rough and spiculated surface becomes smooth and covered with granulations. These unite with the medullary plug, of which they may indeed be looked on as an extension, and finally give rise to the annular bond of union between the two layers of compact bone, to which was originally applied the name '*definitive callus*'.

It will thus be obvious that the continuity of a bone is restored long before the act of repair is completed, and that such union depends on the ossification of the ensheathing callus. The newly-formed osseous tissue is at first soft and spongy, but gradually becomes denser. As the so-called definitive callus becomes stronger, the ensheathing callus disappears, and finally, if the ends are in good position, may vanish entirely, whilst the medullary plug may also be totally removed. Thus it is possible for the bone, under these circumstances, to be restored so absolutely as to show no signs of its having been fractured.

Thus far we have been supposing that the broken ends are accurately apposed and the limb immobilized, but little callus is formed (Fig 144),



and that equally and evenly all round the site of the fracture. Where, however, movement is possible, the amount of callus is much increased.

Where the ends of the bones partially overlap (Fig 145), the amount of ensheathing callus is correspondingly increased, and fills up all the spaces left by the overlapping of the fragments. The projecting margins of bone are rounded off, and the medullary cavities closed by plates or plugs, the amount of definitive callus is usually small, but varies with the actual conditions present. The main bond of union is the ensheathing mass, a considerable portion of which persists. Some deformity is sure to remain after such an accident, and it is unusual for the medullary canal to be restored, frequently one or more plates of bone are found crossing it.

If the fractured ends are not placed in contact at all (Fig 146), the medullary cavity of each fragment is closed by a plate of internal callus, and union is secured by a large mass of ensheathing callus.

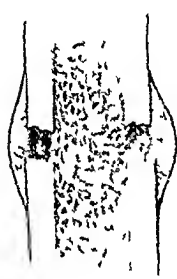


FIG 144

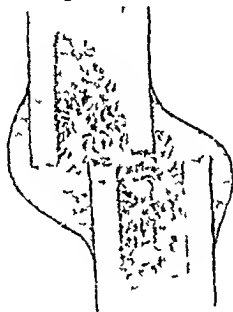


FIG 145

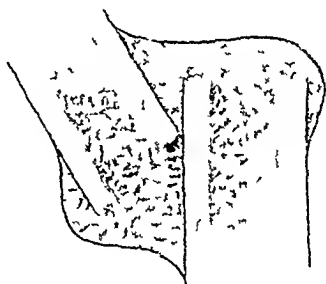


FIG 146

FIGS 144 145 AND 146—DIAGRAMS TO REPRESENT UNION OF FRACTURES. FIG 144, WHEN THE ENDS ARE IN CLOSE APPPOSITION. FIG 145, WHEN THE ENDS ARE ONLY PARTIALLY APPPOSED. AND FIG 146, WHEN THE FRACTURED SURFACES ARE NOT IN CONTACT AT ALL.

Where comminution has occurred, the splintered fragments are matted together by an abundant formation of granulation tissue, which is subsequently transformed into callus.

The soft tissues around—muscles, tendons, etc.—are repaired in the usual way, but such repair is often very imperfect, owing to the infiltration of the parts with blood and the subsequent adhesions that form, so that the functional result may be most disappointing.

The removal of the clot and the formation of granulation tissue usually take about a week or ten days, and new bone formation commences about the end of the first week. By the fourth or sixth week, according to the size and vascularity of the bone and the recuperative power of the individual, the fracture will be consolidated, but in the lower limb it is often eight weeks before the patient can bear any weight upon it. Months may, however, pass before the final stage of complete repair is attained.

In conclusion, one must allude to the fact that a sarcoma sometimes

develops at the site of fracture within a comparatively short time of the accident, and is presumably derived from an overgrowth of the callus

The **Treatment** of simple fractures is sometimes a matter of but little difficulty, although when the bones are much displaced or comminuted, it may not be easy to correct the deformity or to maintain the fragments in position. *Constitutionally*, all that is needed is to restrict the diet and attend to the state of the bowels. This is especially needed in fractures of the lower extremity, where the patient must be confined to bed for some time. In elderly people the general health is very likely to suffer, partly from the shock of the accident, partly from the enforced and sudden change of habit, necessitating a somewhat generous diet and the administration of a certain amount of stimulant.

The **Local Treatment** of a simple fracture consists, first, in *setting* the limb—that is, in reducing the deformity and restoring the fractured ends to a normal position—and then in *fixing* it.

**First Aid**—In moving the patient from the spot where the accident happened, it is necessary to secure the limb temporarily in as good a position as possible, splints have often to be improvised from sticks, umbrellas, newspapers, and so forth. In a railway accident the splintered débris of the carriages may be employed for this purpose, and the upholstery of the seats as padding. A broken leg may also be firmly tied to the other limb, which is thus converted into a temporary splint.

**Reduction** of a fracture is usually accomplished by a combination of traction or extension applied to the lower segment of the limb, with manipulation of the fractured ends, counter-extension being at the same time maintained by an assistant. In some cases it is necessary to relax certain muscles in order to facilitate reduction, thus, in the leg, the lower fragment is drawn up by the tendo Achillis, and to relax this the knee is flexed by an assistant, who holds up the leg and makes counter extension, whilst the surgeon reduces the deformity by traction on the lower part of the limb, section of this tendon is sometimes required in these cases. The manipulation is painful, but, if possible, an anæsthetic should be dispensed with, as one can never be certain whether or not the patient will struggle during its administration. It is unwise to use too much force in order to correct decided shortening from muscular contraction, it is better to relax the muscles by the adoption of a suitable position, or to apply continuous extension. There can be no question that in bygone days patients were subjected to a great deal of unnecessary pain from misguided efforts to 'set' the fracture.

The maintenance of the limb in a good position is provided for by the application of suitable **splints** made of wood, leather, zinc, poroplastic, etc., according to the requisites of the case. If of wood, zinc, or tin, they are usually made according to some general pattern, and fitted to the patient by means of pads, if formed of leather or poroplastic, they can be shaped so as to meet any peculiarities of the part. A paper pattern is first fitted to the opposite limb, and the splint is

then cut to the desired shape, it is softened by immersion in hot or cold water, moulded to the part, and allowed to dry. Where leather is employed, the addition of a little vinegar to the water assists in rendering it soft and supple. The edges and corners are finally rounded, and the interior padded with wool or lint. The general rules relating to the application of splints are as follows: (1) The joints, both above and below the site of fracture should, as far as possible, be immobilized, (ii) the splints must be sufficiently large to firmly encase the part, or if flat, to project a little beyond it, so that the limb may be fixed by the splint, and not the splint by the limb, (iii) careful attention must be given to the padding so as to prevent irritation or sloughing of the skin. In out-patient practice, where the patients are not too careful as to personal cleanliness, it is advisable to pad the splint with some antiseptic material, such as boracic lint, in order to prevent the development of vermin. ~~It is better not to apply a roller bandage under the splint in the situation of the fracture.~~ The splints may often with advantage be first fixed to the limb by one or two turns of strapping, and then secured by ordinary calico bandages, these must not be applied too tightly at first, since the swelling of the limb not unfrequently increases afterwards, and undue constriction resulting in gangrene might ensue. Moreover, a limb ensheathed in bandage must never be flexed, but the flexion should always be made first, if this is not attended to, the bandage may cut into the soft tissues, and by compression of the vessels cause gangrene. It is sometimes advisable to bandage the whole of the limb from the fingers or toes upwards, so as to prevent œdema from the pressure of the apparatus obstructing the venous return. The patient should always be seen on the day following the application of the splints, and the condition of the fingers or toes carefully examined, if they look at all blue, or feel numb and cold, the bandages must be slightly relaxed.

Various forms of **Fixed Apparatus** are used in the treatment of fractures, especially in the later stages when the swelling has disappeared, and in children. The materials most commonly employed are starch, water-glass, and plaster of Paris.

The *starch* bandage is utilized only in cases where great strength and rigidity are not required. The limb is carefully padded with cotton wool, and over this are applied thin strips of cardboard soaked in starch so as to fit the limb. These are firmly secured by a bandage, the meshes of which are well impregnated with a starch solution, and over all may be placed another bandage, the under surface of which is also rubbed with starch. When this dries, it produces a firm mass, sufficient to immobilize the limb. Should it become loose it can easily be readjusted by slitting up and paring away a portion on one or both sides.

The *water-glass bandage* is applied by first swathing the limb with a thick padding of cotton wool, or bandaging it with boracic lint, around this a coarse canvas bandage is applied, soaked in a solution of silicate of soda of the consistency of treacle, several thicknesses of the bandage are required in order to give it the necessary strength. This material

is light, easily applied, and makes very little mess, but is slow in drying, taking fully twenty-four hours to become firm

*Plaster of Paris*, though rather messy and increasing considerably the weight of the limb, is one of the best means of securing prolonged immobilization (a) The dried plaster may be rubbed into a coarse canvas bandage, which prior to use is soaked for a few minutes in cold water, to which a little salt or alum is added in order to hasten its setting, it is then wound round the limb, which has been previously enswathed in boric lint or wool, and on the exterior of this fresh plaster of the consistency of cream is applied To make this cream of the right strength the dried powder is cast in spoonfuls, into a bowl of cold water, or a weak solution of alum, until it no longer sinks immediately, but remains floating on the surface The mixture is then stirred with an iron spoon, and is ready for use When the casing is sufficiently thick, the outer surface is smoothed down with wet hands, or a strip of wet bandage, the date may be advisably marked on it, and the part is slung up to dry A Gigli saw, smothered with vaseline, may be incorporated in the dressing beneath the plaster, if it is desired to remove it early for the sake of massage, etc., by this means it is easily cut into two pieces, which can be re applied daily after the rubbing

(b) Ordinary house-flannel forms the basis of various methods of applying plaster, e.g., Croft's, the Bavarian, etc In the former, the limb, protected by boric lint or wool, has applied to one side of it one or two thicknesses of flannel, suitably cut to shape, soaked in plaster, and with perhaps a little extra plaster rubbed in, it is fixed to the limb by a muslin bandage When this is dry, a similar splint is placed on the other side of the limb, and again bandaged on Division of the bandage down the front permits the removal of the appliance, the bandage over the junction of the two portions behind serving as a hinge If necessary, thin strips of wood or tin may be incorporated in any of these arrangements, so as to add to their strength

Early immobilization by means of plaster of Paris has been advocated by certain Continental and American authorities, and so much confidence have they in it that even fractures of the femur are dealt with in this way within a few days of the accident, and the patient allowed to walk about Such *ambulatory treatment* has not received much support in this country, and does not seem to us in accord with the principles that guide us in restoring a limb to functional as well as mechanical soundness

A most valuable adjuvant in the treatment of fractures is **Massage**, advocated so forcibly by Lucas-Championnière, whilst in some cases **Early Mobilization** is also desirable It has long been recognised that after a fracture the limb remains for some considerable period weak and stiff, owing partly to atrophy of muscles, partly to cicatricial adhesions between various divided structures, and in part to contraction of ligaments in neighbouring joints, and that these disabilities increase in direct ratio to the length of time that the limb is kept at rest It is the object of massage to prevent or obviate these dis-

abilities In a fracture with displacement through the shaft of a long bone, the part is immobilized by splints for a sufficient time to ensure the non-recurrence of the displacement (say, two or three weeks for most bones, a little longer for the femur) Massage is then commenced, and is conducted methodically day by day, the splints being removed for the purpose and re-applied subsequently, neighbouring joints will also be rubbed, and gentle passive movements undertaken Possibly some pain may be noticed at first, but it soon disappears, and the patient experiences a sense of comfort Repair is hastened, but of course the patient must not put any strain on the bone until it is quite consolidated In fractures near joints or through the articular ends of bones, it is sometimes possible to discard splints entirely, or at any rate to use them only for a short time, steadying the part by some simple contrivance, such as a sling or strapping Massage is commenced within a few days and regularly persisted in For such injuries as fracture of the anatomical neck of the humerus, the simpler varieties of Colles's or Pott's fracture, and for some fracture-dislocations in the neighbourhood of the elbow, this plan of treatment has been already proved to be of the greatest service In one case of the first mentioned of these lesions, which we treated by this means at hospital, the result was most gratifying, the limb was merely kept in a sling, and massage was commenced within three days of the accident, within a fortnight the patient (a man of over sixty years) was able to raise his arm without help to a right angle, and he went out with a limb the movements of which were almost perfect

The increasing success of modern aseptic surgery has given considerable impetus to the **Early Operative Treatment** of fractures in order to secure complete fixation and the restoration of function in as short a space of time as possible At first this plan was only utilized for such bones as the patella or olecranon, but at the present day there is no valid reason for refusing operation in any case where it is difficult to maintain the fragments in good position The excellent results following operation in compound fractures, as compared with those gained by the treatment of simple fractures by prolonged immobilization, emphasize this statement It is often impossible to coapt accurately the fragments apart from operation, whilst the infiltration of the soft tissues with blood leads to much fibrosis and the formation of many adhesions, moreover, the more lengthy immobilization results in greater atrophy of muscles and stiffness of joints, and hence the commercial value of a working man after a fracture of the thigh or leg is very considerably depreciated, owing partly to persistent deformity, partly to the joints being stiff, whilst the period of convalescence is reckoned by months rather than weeks Should such a case be operated on, the blood being removed, and the end of the bones freed from intervening tissues and securely united by wires, screws, or pegs, convalescence may be anticipated in a comparatively short time, the bone retains its normal length, early massage of the muscles and joints above and below becomes practicable, owing to the fixity of the limb, and thus atrophy on the one hand, and stiffness on the other, are avoided

At the same time one must not forget that these operations are only justifiable when complete asepsis can be maintained, whilst the manipulative dexterity required in order to bring them to a successful issue is such that, in our opinion, the general practitioner, who undertakes but little operative work in the year, is not justified in performing them

As to the actual *technique*, the incision to expose the bone should be extensive, so as to give plenty of room and allow exit to as much of the extravasated blood as possible. The ends of the fragments are then cleared, and brought into position, attention being directed to make certain that there is no abnormal rotation, and fixed by suitable forceps with a large grasp, *e.g.*, Peters'. The fragments are drilled in one or two places, and silver wire or plated screws introduced, the ends of the wires are twisted up, cut short, and the knot hammered down into the periosteum. Various encircling contrivances of the collar type have been suggested in order to assist in the fixation of the bone, and may sometimes prove useful.

**Complications arising during Treatment**—(1) If an elderly patient is kept in bed for any length of time in the recumbent posture, *hypostatic pneumonia* is likely to ensue. It occurs most commonly after intracapsular fractures of the cervix femoris, and non-union often results, since the patients must be allowed to get about on crutches at an early date, the limb being merely fixed by a Thomas's splint.

(2) *Bedsores* are very liable to supervene in old people with fractures which need treatment in the recumbent posture. (3) *Crutch-palsy* is the result of compression of the brachial nerves between the head of the humerus and the pad of a crutch. It may affect all the nerves of the upper extremity, or may pick out any one of them, and then most commonly the musculo-spiral. It can usually be prevented by the use of spring-padded crutches with cross-pieces for the hands, so as to allow the patient partially to relieve the axillary pressure by supporting the weight of the body by means of the arms. When it has occurred, the use of crutches must be discontinued, and faradism and massage employed to the affected muscles. (4) When the muscles of a part have been firmly compressed by splints, they may undergo a rapid intrinsic atrophy with contraction, constituting what is known as *Isch...* This is observed most frequently in the hand, and is

direct pressure of the splints on the muscles of the forearm. The fingers become clawed and flexed, and the wrist is sometimes hyper-extended. It is recognised from the results of a nerve lesion by the absence of sensory or trophic phenomena. Treatment consists in exposing and lengthening the contracted tendons, if massage fails. The outlook is, however, not very promising. (5) *Gangrene* may arise from fractures in a variety of ways. (i) From the immediate effects of the injury, either by its direct action on the tissues, or by causing arterial thrombosis in a limb with atheromatous vessels, or from rupture of the artery with consequent venous thrombosis, owing to the pressure of the extravasation, (ii) by the super-vention of spreading gangrene in a compound fracture, (iii) from errors in the course of treatment, as by bandaging the limb too

tightly, so as to constrict the vessels, or by the bandage becoming unduly tight, owing to the subsequent swelling of the limb, or by flexing a joint after bandaging it, the bandage cutting into the soft tissues, or by the localized pressure of a splint which has been insufficiently padded. Moist gangrene is the type met with in all cases, except when the limb has been previously drained of its fluids by an atheromatous condition of its vessels. (For rules of treatment, see Chapter VI.)

### Compound Fractures

A compound fracture is one in which there is a communication between the external air and the site of injury. It is produced by direct or indirect violence, and may be associated with any of the complications or modifications met with in simple fractures. The bones may be but little displaced, or may protrude through the opening in the skin, and then be bruised or comminuted, and even contaminated with dirt or mud.

The chief dangers of compound fractures are, firstly, *hæmorrhage*, the blood, instead of collecting within the tissues of the limb, escaping externally, although subcutaneous extravasation is not uncommon, and, secondly, the advent of *sepsis*. The latter is the more important, and may lead to the most serious consequences. Portions of muscle and periosteum, which in a simple fracture would be removed or incorporated in the new formation of callus, become inflamed in septic cases, and even slough. Small isolated fragments of bone are almost certain to necrose if suppuration ensues, whilst the severest forms of *septic osteomyelitis* may occur, endangering the patient's life by *pyæmia*. Such results are more likely to follow when the external wound is small and insufficient provision has been made for drainage. Immense advances in the treatment of these conditions have been made since the introduction of antiseptic surgery, and where such is regularly and efficiently practised these dangerous complications are rarely seen.

The **Method of Union** of a compound fracture is much the same as that occurring in simple fractures. If the wound can be rendered aseptic, it may be closed by suture, and if it heals by first intention the fracture is practically converted into a simple one, and is repaired accordingly. If, however, suppuration occurs, it is probably attended with a greater or less amount of necrosis, and possibly diffuse inflammation of the soft parts, the wound will therefore remain open for a time, varying with the acuteness of the local phenomena. It is gradually closed by granulations, which extend upwards from below, and the deepest part of this granulation tissue, which is derived from the bone and periosteum, and contains osteoblastic elements, will be transformed into callus, and finally into true osseous tissue. Repair is much slower under these circumstances than in a simple fracture, since the suppuration may have interfered with the osteogenetic powers of the periosteum, and thus the new bone formation is dependent solely on the osseous tissue itself, which is always slow to react.

The **Constitutional Symptoms** following compound fractures are much more marked than in simple cases. Even where sepsis is prevented by efficient treatment, some amount of aseptic traumatic fever is certain to supervene for a few days, whilst, if infection occurs, there is a period of marked febrile disturbance for a week or ten days, similar to that which is seen in all septic lacerated wounds (p 230).

In the **Treatment** of compound fractures, the main object is to render the wound aseptic and to give efficient exit to the discharges. For this purpose the patient should in most cases be anæsthetized, the wound enlarged and thoroughly washed out, and even scrubbed, with some potent antiseptic, such as carbolic lotion (1 in 20). Loose fragments of bone are removed, and portions denuded of their periosteum may be taken away lest necrosis should ensue; where fragments retain any considerable connection with the soft parts, they may be left without fear, and of course as little periosteum should be removed as possible. When a sharp end of one of the fragments is protruding through a small opening in the skin, it is first thoroughly purified before attempting its reduction, and then replaced, after enlarging the wound in the skin, or a portion is sawn off. Hæmorrhage is dealt with in the usual way, and the fragments are placed as nearly as possible in their normal position. If the fragments can be brought accurately into position, it is well to fix them by some mechanical appliance, but where the ends of the bones are much comminuted, the small portions must be arranged in position as well as possible, and no attempt made to wire them. A good-sized drainage-tube is inserted, and, if need be, counter-openings are made, the external wound is closed or not according to circumstances and dressed, and suitable splints are then applied. Under such a régime the majority of cases do well. Immoveable apparatus may be used after a time, windows being left in the plaster casing to allow wounds to be dressed.

In compound fractures which have been attended with complications directed to vessels, nerves, and neighbouring soft parts or joints, the prognosis and course of the case may be considerably modified, treatment suitable to each of these conditions must be adopted.

The question of **Amputation** will necessarily be raised in the more serious cases, but it is unnecessary to add anything here to what has already been stated in Chapter IX (p 231).

### Ununited Fractures

Three varieties of ununited fracture have been described. (1) Absolute non union is said to be present when no attempt at repair is made. This rarely occurs except when some definite bone disease exists, such as sarcoma or osteomalacia, or when in a very debilitated patient there has been no attempt to fix the limb. (2) Fibrous union consists in the development of a more or less firm mass of connective tissue as the bond of union between the ends of the bones, which are either rounded off and closed by a thin plate of bone or cartilage, or are sometimes atrophic and pointed. (3) A false joint, or pseudarthrosis,



is a condition in which the ends of the fragments are covered either by bone or cartilage, and more or less altered in shape, so as to form a shallow ball-and-socket joint, the capsule being represented by the surrounding fibrous tissue, and the synovial cavity by an adventitious bursa, which results from the friction of the two ends (Fig 147)

The most common situations for ununited fractures are projecting processes of bone to which powerful muscles are attached, such as

the patella, olecranon, coracoid process, posterior half of the os calcis, etc., whilst in long bones the middle of the shaft of the humerus and the upper and lower thirds of the femur are the favourite sites

Many different **Causes** may be associated in determining the defective union of fractures, but the following are the more important

(1) Want of apposition of the bony ends, owing to muscular action—e.g., in the patella, when the two fragments are widely separated, or in the femur, where they may overlap, (2) the interposition of fluid or such substances as muscular or aponeurotic tissue, or detached fragments of compact bone, (3) want of rest, one of the most common

FIG 147 — UNUNITED FRACTURE WITH FALSE JOINT (FROM COLLEGE OF SURGEONS' MUSEUM)

causes, as in the middle of the shaft of the humerus, where, unless the elbow is well supported, complete immobility cannot be obtained, and non-union is likely to result, (4) defective blood-supply to one or both fragments, as by injury to the nutrient artery, or as in intra-capsular fracture of the cervix femoris, where the only source of supply to the upper fragment is a small twig derived from the obturator artery running along the ligamentum teres, (5) local affections of the bone, such as malignant tumours, destruction of the periosteum by inflammation, or the undue pressure of pads upon the newly-formed callus, (6) general bone disease, as osteo-malacia, and (7) general constitutional weakness or debility, sometimes due to definite diseases, such as scurvy or severe syphilis, sometimes to general asthenia or alcoholism. It has been proved that senility, pregnancy, and the cancerous cachexia do not, as used formerly to be stated, predispose to this condition

The **Signs** of an ununited fracture are usually obvious, mobility

between the fragments being easily obtained, although without crepitus

The **Prognosis** is good if suitable treatment is adopted. In children, however, the condition is often maintained even after operation, and, in fact, may be aggravated by it, the ends of the bone becoming atrophic, rounded, and covered by cartilage, in such the final resource is not unfrequently amputation.

The **Treatment** of ununited fractures is now conducted on perfectly definite lines—(1) If in good position, the parts are fixed in an immovable apparatus, preferably plaster of Paris, for six weeks, whilst means are adopted to improve the general health, as by a stay at the seaside and the administration of tonics. (2) Failing this, the ends of the bones may be well rubbed together, so as to excite local action; and the parts again fixed. Regular massage is useful, and enforced congestion of the limb by an elastic tourniquet applied for an hour or two daily has also been recommended. (3) Should this be unsuccessful, or if the ends of the bone are not suitably apposed, operative measures must be undertaken. If the bone is tolerably superficial, and the ends not very far apart, they should be exposed, sawn into shape, fitted together (preferably by a dove-tailing process), and secured by stout silver wire, which may be left *in situ* permanently, and if aseptic becomes encapsuled. If, however, the bones are deeply placed, so that the operation to expose the ends and fit them together becomes a very severe one, it is often better practice to leave them in their bad position, and merely fix them by the insertion of ivory pegs or nickel-plated screws. Thus, in the upper end of the femur non-union is usually associated with overlapping of the ends of the bone to a considerable extent. To expose and fit these together would necessitate a very extensive dissection, it is wiser in such cases merely to cut down in front upon the upper anterior fragment, drill two holes in different directions through both fragments, and into these insert suitable ivory pegs. Two holes should always be employed, to prevent slipping of the fragments during the necessary manipulations, whilst one drill is removed for the insertion of the peg, the other holds the bone steady. As a rule, the pegs may be allowed to remain permanently, but occasionally they become loose in three or four weeks, and need removal. Their presence causes the formation of a large amount of callus, and by this means the fracture is consolidated. It is well to examine the fracture by the X rays from time to time to see that the bones are still in position, and for this purpose the dressings need not be removed, if metal splints are not used.

**Disunited Fracture** is the term applied to a rare condition, in which a fracture which had been firmly united becomes separated again. It is only met with when the individual develops some extremely debilitating disease, such as scurvy, and may be recovered from under suitable treatment directed to the cause, and by fixation of the parts.

**Vicious Union** (Fig. 148) of fractures results either from imperfect adjustment of the ends of the bone prior to placing the limb on an immovable apparatus, or from the parts not being kept at rest, and hence becoming subsequently displaced. Various kinds of deformity

and disfigurement, accompanied or not by loss of function, may result from this accident. In some cases it may be advisable to leave things alone, but where the deformity or functional disability is serious, means must be taken to remedy matters. If observed early, it is not difficult to re-adjust the parts by simple pressure under an anæsthetic, if necessary re-fracturing the bone, but this should only be under-

taken whilst the callus is soft, *i.e.*, within three or four weeks of the accident. Some surgeons apply this method of *osteoclasis* even when consolidation has been accomplished, using for the purpose powerful levers and clamps, but in our opinion such treatment is most undesirable and highly unscientific, since it is difficult to gauge accurately the amount of damage concurrently inflicted on the soft parts. We much prefer the *open* method, cutting down on the bone, re-dividing it, removing redundant callus, and fixing the fragments by silver wires, pegs, or screws.



FIG 148 — VICIOUS UNION WITH MARKED DEFORMITY AFTER FRACTURE OF FEMUR (KING'S COLLEGE HOSPITAL MUSEUM)

### Special Fractures

**Bones of the Face**—The Nasal bones are broken as a result of direct violence, by the fist, a cricket-ball, stick, etc. The fracture is generally transverse, and situated just above their free margins, occasionally, when

greater force is used, it occurs close to the root of the nose, and may then be associated with fracture of the frontal bone or base of the skull. In young people the cartilages alone may be separated. There is usually considerable deformity from depression or lateral displacement of the fragments, although it may at first be masked by the amount of bruising. Severe epistaxis, surgical emphysema, and cerebral symptoms, are sometimes met with as complications. The fracture very readily becomes consolidated, and the deformity is thus often irremediably fixed, unless its presence is determined at once, and suitable treatment adopted. The **Septum** is sometimes broken and depressed, in association with or apart from the above injury. Lateral displacement occurs, causing unilateral nasal obstruction and some amount of obvious deformity. The **Treatment** of these cases consists in immediate replacement of the bones, advisably under an anæsthetic, this may be accomplished by the pressure of some blunt instrument, such as a pair of padded dressing-forceps, the

blades of which are introduced within the nostril, or by distension of a suitable indiarubber bag with air or water. A pad of lint or gauze soaked in carbolized oil is then inserted to maintain the position, and a guttapercha or zinc splint moulded to fit the bridge. In old-standing cases, where there is much depression, but little can be done by operation, but subcutaneous injections of paraffin may improve the appearance (see Chapter XXVIII). Lateral displacement can usually be remedied by mechanical appliances or operation.

The **Lachrymal** bone has been broken by direct violence, the fracture usually extending from the nasal bone to the lateral mass of the ethmoid. Interference with the flow of tears and surgical emphysema are the two most marked symptoms.

The **Malar** bone is but rarely broken without the other bones of the face being involved, fracture is almost always associated with damage to the anterior wall of the antrum and considerable depression of the fragments. An attempt should be made to replace the parts by pressure from within the mouth.

The **Zygoma** is fractured by direct violence applied from without, the broken portion may be depressed below the surface, but vertical displacement is limited by the attachment of the masseter below and of the temporal fascia above. Reposition, either by manipulation from within the mouth, or even by operation, is essential in order to prevent interference with the subsequent mobility of the jaw. Perhaps the simplest plan to adopt is to encircle the zygoma subcutaneously with a loop of silver wire and drag it up to its natural level.

The **Superior Maxilla** is invariably broken as a result of direct injury, such as a gunshot wound or a blow, it is almost always compound, and often bilateral. The alveolar portion is either partially or entirely detached, or a transverse fissure, extending as far as the pterygoid processes on each side, may render the whole palate and lower part of the facial skeleton moveable. Not unfrequently all the bones of the face are smashed and comminuted, severe hæmorrhage sometimes resulting from wounds of the internal maxillary artery or its terminal branches. As a rule, **Treatment** consists in merely keeping the patient quiet and applying cooling lotions, union occurs with great readiness, but is sometimes associated with suppuration and necrosis. The patient must be fed by a tube, and a carefully-fitted dental plate should be applied to a broken alveolus.

The **Inferior Maxilla** is usually fractured by direct violence, but occasionally by force applied indirectly, as when a carriage passes over the bone, laterally compressing the two sides, and leading to a fracture in the middle line. Most frequently the lesion is a little in front of the mental foramen (Fig 149), this being a weak spot at the junction of two strong parts, viz, the symphysis menti, and the alveolar process carrying the molar teeth, the bone is further weakened by the long narrow alveolus which lodges the canine tooth. This fracture is sometimes bilateral when great violence has been applied to the symphysis. A solution of continuity also occurs close to the angle behind the molar teeth, whilst the coronoid process and

condyle have occasionally been broken, the former only as a result of great force, *e g*, a gunshot wound, the latter from either direct or indirect violence

The Signs of fracture are very evident if the lesion is situated anteriorly, but when behind the teeth, diagnosis may be much more difficult. The usual variety is almost always compound, owing to the firm attachment of the muco-periosteum to the alveolar border. Laceration of the gums, the blood-stained saliva soon becoming foetid, the irregularity in the line of the teeth, and the easily elicited crepitus, all constitute a typical picture. There is often considerable pain, owing mainly to the tearing of the mucous membrane, but possibly due to implication of the inferior dental nerve. The main trunk, however, generally escapes, owing to the position of the fracture in

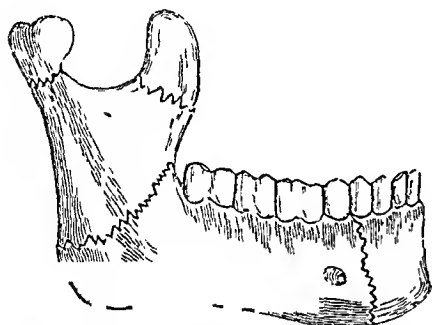


FIG 149—LOWER JAW INDICATING THE MOST COMMON SITES OF FRACTURE



FIG 150—APPLICATION OF FOUR-TAILED BANDAGE FOR FRACTURE OF LOWER JAW

front of the mental foramen, whilst in those behind there is but little displacement. Smart hæmorrhage sometimes occurs from laceration of the accompanying artery. The posterior fragment is usually raised, whilst the anterior portion is depressed by the action of the hyoid muscles, and may override the other, owing to the direction of the fracture, the anterior fragment including more of the outer surface of the bone than the posterior. The direction of the displacement is reversed in some cases. When situated at the angle or *in the vertical ramus*, there is such equal muscular support on the two sides that but little displacement results. When the fracture passes *through the neck of the condyle*, that process is drawn forwards and inwards by the external pterygoid, whilst the body of the bone is freely moveable antero-posteriorly, and displaced towards the fractured side. When the *coronoid process* is detached, it is dragged upwards by the temporal tendon, but no great displacement can occur, owing to the extensive attachment of the tendinous fibres.

In those cases of fracture which are compound (and this includes the great majority), septic inflammation of the ends of the bone often

ensues, leading to localized necrosis, and sometimes to septic pneumonia, or even to general pyæmia

The **Treatment** of a fractured mandible is frequently a matter of difficulty, owing partly to the septic element, and partly to the difficulty of fixing the jaw without interfering with the patient's nutrition, hence the co-operation of a skilled dentist should always be secured

1 As a temporary measure, and indeed as a permanent appliance in simple cases without much displacement of the fragments and where dental assistance is not to hand, all that is needed is an efficient four-tailed-bandage. This is made by taking a piece of calico 4 inches wide and 1 yard in length, and splitting each end into two, leaving about 8 inches undivided, in the centre of which a small longitudinal cut is made for the insertion of the chin. The two lower tails are then drawn up and tied over the vertex, whilst the two upper ends are secured behind the occiput, and then, to prevent slipping, are



FIG 151 —LEATHER SPLINT FOR LOWER JAW



FIG 152 —LEATHER SPLINT APPLIED

knotted to the ends of the former (Fig 150). This apparatus is maintained firmly in position for three weeks, the patient being fed through a tube passed between the teeth or through the gap behind the last molar, and all movement of the jaw prohibited. The mouth should be frequently washed out with some antiseptic lotion. Union is usually secured in five weeks.

2 If patients are unruly, or if the above apparatus fails to maintain the fragments in position, a moulded gutta-percha or leather splint may be applied, made in the shape indicated in Fig 151, the upper portion being folded back, and the lower portion drawn up around the bone. It is lined with lint, and secured by bandages or tapes passed through holes, and tied as shown in Fig 152.

3 Where there is much displacement, the fragments must be fixed. Wire sutures passed around or between adjacent teeth and tied are distinctly objectionable, causing the teeth to become loose and perhaps diseased. Hammond's wire splint is the best apparatus to employ. It consists of a thin wire collar or framework (Fig 153), which encircles the whole series of teeth in the lower jaw. It is accurately fitted by

a dentist, firstly, to a cast of the jaw, subsequently to the jaw itself, and is fixed by several wires passing from one half to the other between the teeth

4 In cases where a Hammond's splint fails in remedying the displacement, or where the teeth are defective, a Kingsley's apparatus (Fig 154) may be used with advantage

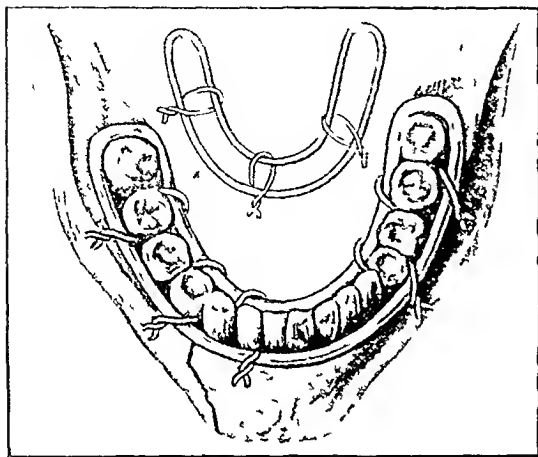


FIG 153 —HAMMOND'S SPLINT FOR FRACTURE OF LOWER JAW

It consists of a vulcanite splint fitted over the teeth or alveolar process of the mandible, and extending for a sufficient distance on each side of the fracture to steady the fragments. To the front of this are attached curved metal bars, which extend sideways from the angles of the mouth over the cheeks. It is kept in position by passing a bandage over the bars and under the chin (Fig 155), and secures thereby excellent immobilization of the fragments, even when the mouth is opened

5 Wiring of the jaw ments together may be required in a few cases. The wires must be passed either through the bone below the teeth—a task not easy to accomplish without an external wound—or through the empty alveoli of neighbouring teeth, which are extracted for the purpose

When septic inflammation occurs of such severity as to lead to necrosis, it is often best to delay all operative treatment until the sequestrum has been detached, and the parts are more healthy, the patient's mouth in the meantime being frequently cleansed with antiseptic lotions. Wiring of the fragments may then, if necessary, be undertaken with good hope of success

**Fracture of the Hyoid Bone** is uncommon, arising usually from direct violence, such as a forcible grasp or the constriction of the neck in hanging. Either the body may be broken, or one of the cornua separated. The symptoms produced are Pain on attempting to move the tongue, jaw, or neck, a husky voice, and deformity, which can sometimes be detected from without. Occasionally the mucous membrane is perforated, and bleeding into the pharynx may occur, whilst œdema of the glottis may supervene. The fragments should be approximated as well as possible by manipulation between one finger in the mouth and the hand outside, and the neck then fixed by a poroplastic collar

**Fracture of the Ribs** may arise in two distinct ways (1) By direct violence, as by blows or stabs, the fragments being driven inwards,

and damage to the underlying pleura, lungs, liver, or diaphragm, being very likely to occur, or (2) much more frequently by indirect violence, as when the chest is compressed between a cart wheel and the ground, or between a wall and the back of a waggon. The ends of the ribs are then approximated beyond the limits of natural elasticity, and they give way at the most convex part—*viz.*, near the angle. The viscera may be contused, but less often than in the former class, although hæmothorax from rupture of the parietal pleura is not uncommon. One or several ribs may be broken, but the displacement is rarely marked, except in cases due to direct violence, where several ribs have been 'staved in'. The fifth to the eighth ribs are those usually injured, being more prominent and fixed at both ends, the first

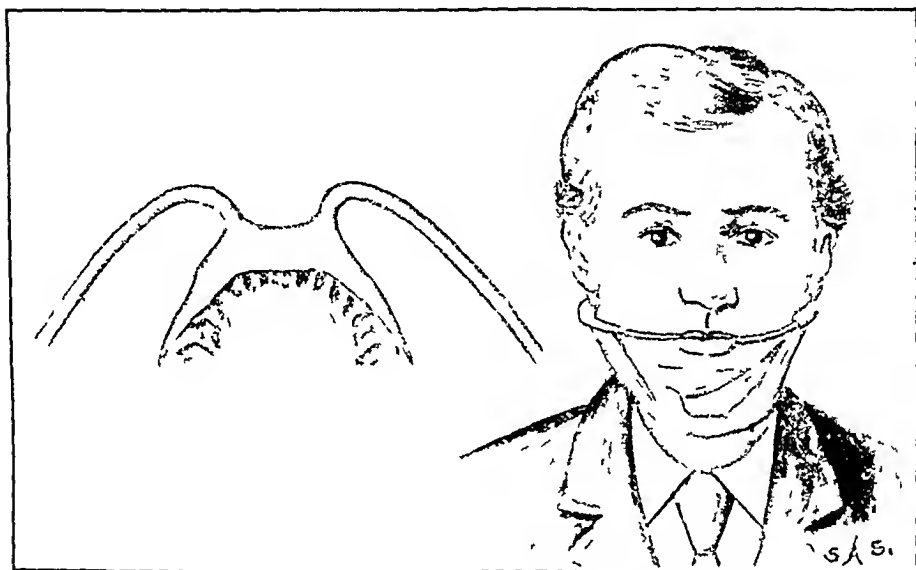


FIG 154

KINGSLEY'S SPLINT FOR FRACTURE  
OF LOWER JAW

FIG 155

KINGSLEY'S SPLINT  
APPLIED

and second ribs are so well protected by the clavicle as to be seldom broken by direct injury, although great violence from above downwards to the outer end of the clavicle may lead to such an accident, the lower ribs often escape on account of their greater mobility. Elderly women and persons suffering from general paralysis of the insane are specially prone to this fracture.

The **Symptoms** are tolerably obvious, *viz.*, a sensation of something snapping or giving way, a sharp localized catching pain at the site of the injury, increased on deep breathing and coughing, and possibly some local extravasation and swelling. Pain is also elicited by conjoined pressure upon the sternum and spinal column, whilst the fracture may be evident on palpation, or crepitus detected when the patient coughs or on auscultation. When several ribs are driven in, a marked



depression results, but if a single bone is broken in a fat individual, the diagnosis may be extremely obscure. For the clinical history of lesions of the lungs or pleuræ, see Chapter XXXII.

**Treatment**—The affected side should be firmly strapped with broad strips of adhesive plaster, so as to limit its movements. The strips,  $1\frac{1}{2}$  to 2 inches wide, should extend beyond the middle line, both front

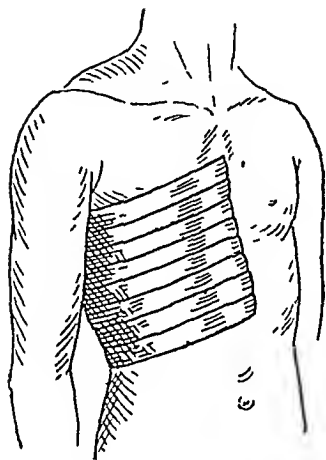


FIG 156—METHOD OF STRAPPING BROKEN RIBS

and back, and are applied from below upwards whilst the chest is in a state of forcible expiration, each strip overlapping the preceding one and crossing the direction of the ribs (Fig 156). A firm woollen bandage should then be applied over all. If the ends of the bone are driven inwards, strapping can rarely be borne, as it tends still further to irritate or compress the lung. Under such circumstances all constriction of the chest must be avoided, the patient being confined to bed with a sandbag between the shoulders, and the arm bound to the side. When the lower ribs are broken, tight applications are generally contraindicated, since the diaphragm is likely to be irritated, and troublesome hiccough may result. Ribs unite readily, but with a

considerable amount of callus, owing to the mobility of the fragments.

**Separation of a Costal Cartilage** sometimes occurs, giving rise to the same symptoms and requiring the same treatment as a broken rib. Occasionally the cartilage itself may be fractured. In each case the resulting bond of union is osseous.

**Fracture of the Sternum** is almost always due to direct violence, although it has been known to yield from excessive flexion of the body after fracture of the spine, or from muscular strain during parturition. The line of fracture is usually transverse, the bone giving way either between the manubrium and gladiolus or a little below this level. The fragments may remain *in situ* or the upper portion be displaced backwards, the deformity in such cases being very evident, and great dyspnoea resulting. As a late effect, aneurism of the arch of the aorta may occur.

**Treatment**—The patient should be kept in bed with a pillow between the shoulders, and the chest strapped as for fractured ribs. If the patient cannot bear this position, he should be allowed to sit up with the body leaning forwards. Reposition can sometimes be effected by manipulation, combined with extension of the spine.

### Fractures of the Upper Extremity

**Fracture of the Clavicle**—No bone in the body, with the exception of the radius, is broken more frequently than the clavicle, this is due to its exposed position and its buttress-like action in keeping out the

point of the shoulder, so that every shock to the arm is transmitted through it to the trunk. Hence, although sometimes broken by direct violence, fracture is usually due to force directed to the hand or shoulder, such as a fall from a horse. It is more common in men than in women, and in children is often of a greenstick nature. The bone may yield in four different situations, viz

1 **At the Sternal End**, an unusual occurrence, due to direct or indirect violence. The displacement varies with the line of fracture, if transverse, it is slight, but if oblique, and this is most usual, the outer fragment is drawn down wards and forwards as in the next variety, though to a less degree.

2 **Through the Greater Convexity**, the commonest situation.

The bone yields about its centre, or a little external to it, and the line of fracture is slightly oblique, running from before backwards and inwards. The displacement is quite characteristic, and is present in any fracture situated between the rhomboid ligament on the inner side and the coraco-clavicular ligaments on the outer, being less marked, however, when the fracture is nearer the extremities than in the centre of this space. The patient gives a history of injury and severe pain, supports the elbow with

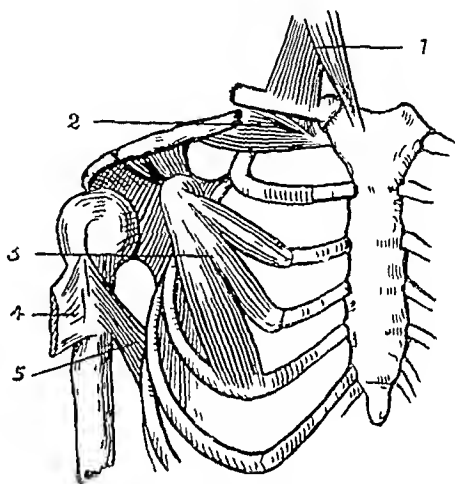


FIG 157 — FRACTURE OF CLAVICLE THROUGH GREATER CONVEXITY

1, Sterno-mastoid, 2, subclavius, 3, pectoralis minor, 4, pectoralis major, 5, trapezius

the other hand, the head being bent over to the affected side to relax the muscles of the neck, and the arm is powerless. The point of the shoulder is less prominent than usual, being approximated to the middle line, and on a lower level than the other, whilst at the seat of fracture is a slight bony projection. This deformity is accounted for by a displacement of the whole outer fragment downwards, forwards, and inwards (Fig 157), the outer end, however, is more displaced than the inner, so that the fractured surface of the outer fragment looks upwards, inwards, and backwards, although it is placed immediately below the inner fragment. The deformity is mainly due to the weight of the arm acting upon the outer fragment when the buttress like action of the bone is gone, allowing the scapula, to which it is firmly united by ligaments, to embrace the curved-thoracic-wall from which it is usually separated. Muscular action can only be looked on as an accessory, and is not the main cause of this displacement. The position of the inner fragment is probably but little altered, since it is held in place by the rhomboid ligament, the apparent

projection of its outer end is due rather to the depression of the outer fragment than to elevation of the inner by the sterno-mastoid

3 **Between the Coraco-clavicular Ligaments**, usually arising from direct violence, and with but little displacement, owing to the tension of the ligaments and to the fact that the periosteum is not torn across. The signs of local trauma and crepitus are, however, present, though not very obvious

4 **At the Acromial End**, external to the trapezoid ligament, and, again, usually produced by direct violence. The inner fragment retains its position unaltered, but the outer fragment is dragged down by the weight of the arm, and forwards by the action of the muscles, so that it lies at right angles to the rest of the bone

**Complications** arise most frequently in cases produced by direct violence. The subclavian vein may be injured, or the brachial plexus, and even the dome of the pleura and the subjacent lung have been wounded. Gangrene of the arm has resulted from obstruction to the vessels

**Treatment**—Where there is little or no displacement, all that is needed is to immobilize the arm in a sling and to keep the patient quiet

For fractures with displacement many different plans of treatment have been adopted. In order to replace the fragments, the surgeon should stand behind the patient, who is seated, with his knee between the scapulæ, traction is then made upon the shoulders, and the point of the acromion is drawn upwards and backwards. To maintain the fractured ends in apposition the following methods have been recommended (a) The simplest, which can always be applied in an emergency and in simple cases permanently, is that known as the *three-handkerchief plan*. Two large handkerchiefs, folded double and rolled into bands, are placed vertically, one over each shoulder and under each axilla, each is lightly knotted behind, and the ends firmly tied to the opposite handkerchief across the middle line. By this means the point of the shoulder is kept outwards and backwards. The third handkerchief is now folded crosswise and used as a sling to support the elbow, which is drawn well forwards, the hand being placed over the sound clavicle. If this apparatus is employed permanently, the knots must be examined every few days, especially at first, as the handkerchiefs always stretch a little and require occasional tightening. (b) *Sayre's method* is very useful, especially in treating children. A long strip of adhesive plaster,  $3\frac{1}{2}$  inches wide or less, according to the size of the patient, is passed round the arm a little below the axilla, as a loop, with the sticky side out, and then around the body with the adhesive side inwards, the arm being drawn well back, and the loop and ends secured by stitches (Fig 158). If this has been firmly applied, it may now be used as a fulcrum, so that as the elbow is drawn forwards, the point of the shoulder is directed backwards and outwards, and thus the main deformity is overcome. Another strip of a similar width is applied over the elbow (a small hole being cut to receive the point of the olecranon), and by this means the arm is raised and drawn forwards so that the hand can be placed on

the opposite shoulder, and the desired position is thus maintained. In children more than one strip of plaster will be needed in order to secure the arm, whilst an additional bandage is also useful. Excellent results follow this plan of treatment. (c) In ladies, where even the slightest deformity is undesirable, it is better to confine them to bed, the head is kept low without a pillow, and a sandbag placed between the scapulæ, the arm being bandaged to the side. This position must be maintained for three weeks, and even then only very limited movement allowed. (d) The old-fashioned plan of treatment by means of an axillary pad, a figure-of-8 bandage crossing behind the shoulders, and an elbow sling, has been to a large extent superseded by Sayre's and other methods. Union is probably attained in four weeks, but the movements of the arm should be restricted for some time longer. A considerable amount of callus is usually formed, and there is very likely to be some slight persistent deformity.

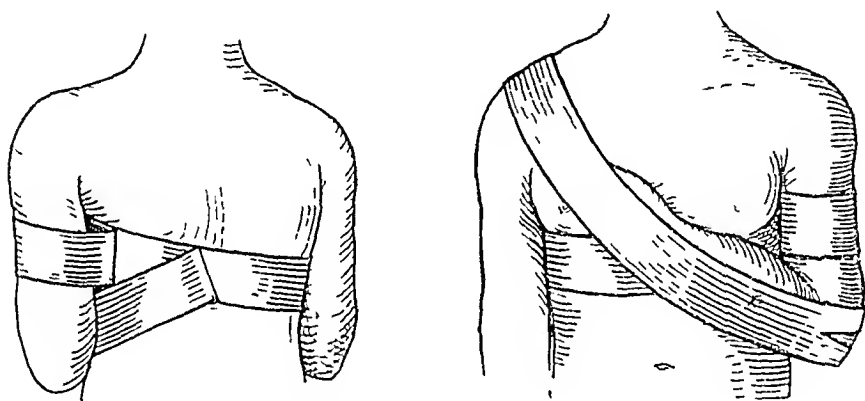


FIG 158—SAYRE'S METHOD OF STRAPPING FOR FRACTURED CLAVICLE

**Fractures of the Scapula** —1 The **Acromion Process** may be broken by direct violence applied to the point of the shoulder. The arm hangs powerless, supported by the other hand, and the shoulder is flattened. The irregularity of the bone can be readily detected, and crepitus can be elicited by raising the elbow and rotating the arm. Occasionally merely the tip is detached, and then the above signs will not be present. **Treatment** consists in raising the elbow, and bandaging the arm to the side.

2 The **Coracoid Process** is rarely fractured, and then by direct violence. There is but little displacement, on account of the many powerful ligaments attached to it, and the only treatment needed is to raise the elbow by a sling and keep the arm to the side.

3 The **Body of the scapula** is broken as a result of considerable direct violence, which is often primarily received by the spine. There is but little displacement when the fracture is comminuted or transverse just below the spine. A longitudinal fracture may, however, result in the inner or vertebral fragment being drawn upwards.

and outwards in front of the axillary portion by the serratus magnus and levator anguli scapulæ. The diagnosis is made by grasping the bone firmly, and moving one fragment on the other, crepitus may thus be obtained. **Treatment** consists in bandaging the arm to the side, and possibly applying strapping to support the fragments.

4. Fracture of the **Neck** is usually due to great violence directed to the shoulder, but is uncommon. A portion of the articular surface

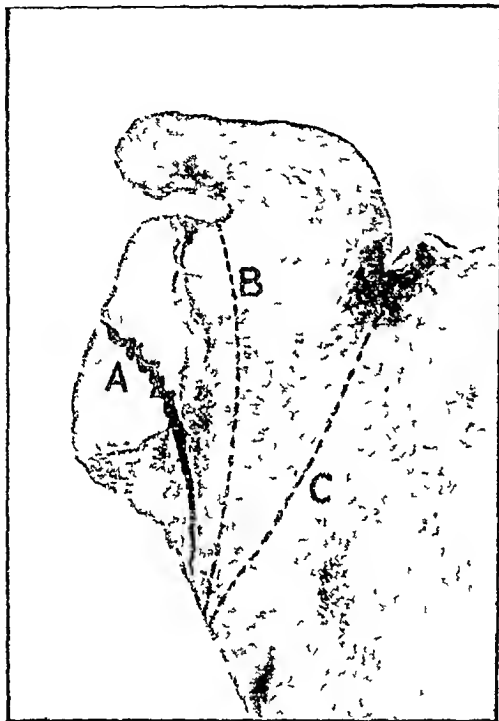


FIG 159—FRACTURES OF THE NECK OF THE SCAPULA

A, Through the glenoid fossa, B, through the anatomical neck, C, through the surgical neck

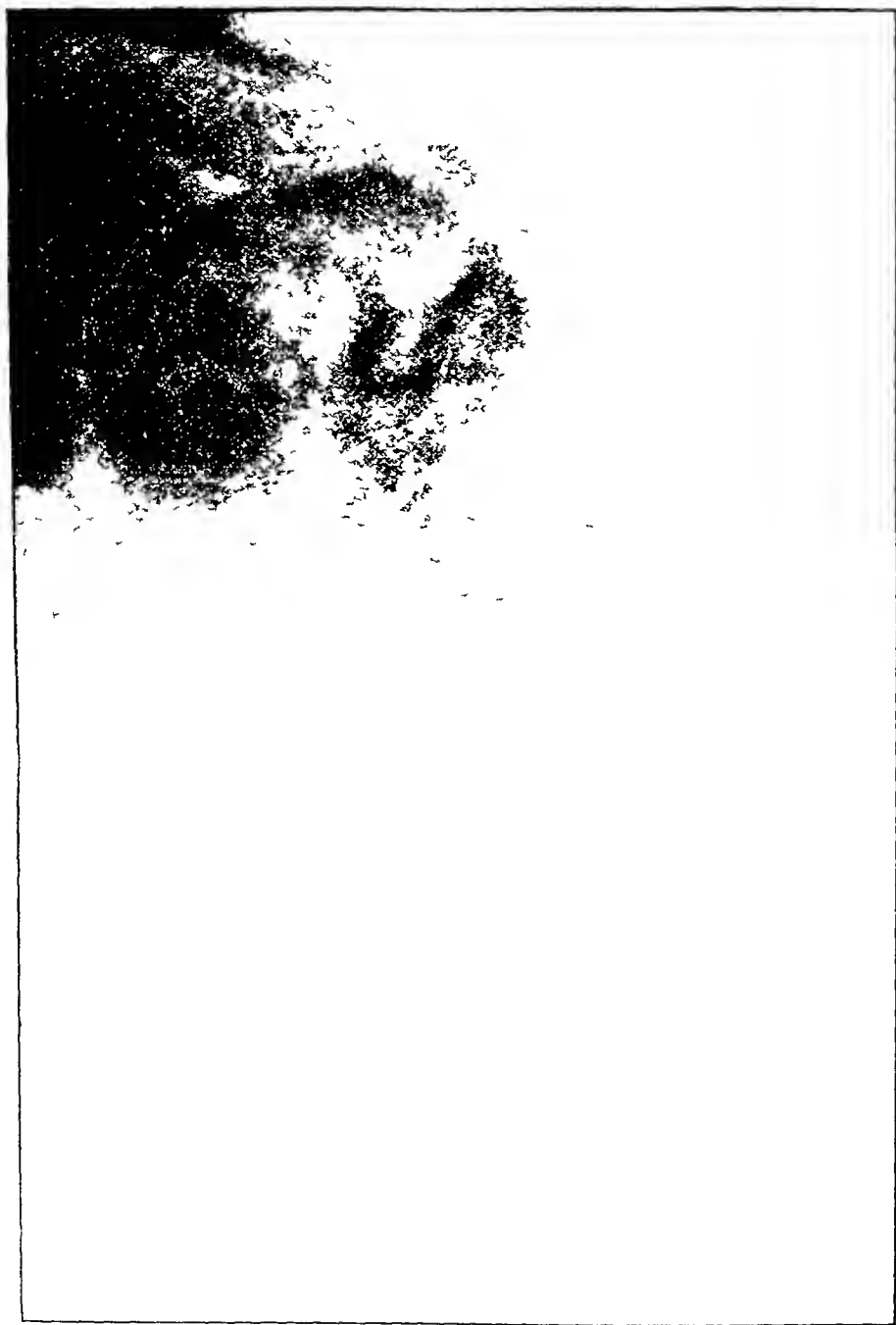
is broken off and displaced downwards in some few cases of dislocated shoulder (Fig 159, A), or the fracture has been known to run through the anatomical neck (Fig 159, B), either condition causing slight lengthening of the arm, and displacement downwards of the head of the humerus. **Treatment**—The arm must be kept to the side and raised.

More commonly, however, the fracture involves the **Surgical Neck** (Fig 159, C), extending from the suprascapular notch above to just below the origin of the triceps muscle, so that the detached fragment includes the coracoid process. Flattening of the shoulder results, with prominence of the acromion, lengthening of the arm as measured from the acromion to the external condyle, and crepitus on raising and rotating the limb.

**Treatment**—The bone is replaced by pressure in the axilla, if necessary under chloroform, and fixed by an axillary pad or a  $\cap$ -shaped leather splint, whilst the arm is kept to the side.

**Fractures of the Upper End of the Humerus**—1. Of the **Anatomical Neck**, the so called '**Intracapsular Fracture**' (Plate VII). This is usually due to blows or falls on the shoulder, less commonly to indirect violence. The shoulder becomes greatly swollen from effusion of blood, making a satisfactory examination almost impossible for some days, pain on movement is severe, but crepitus may perhaps be felt on rotating the arm, there is usually about half an inch of shortening. In most cases the upper fragment is not totally detached, but remains

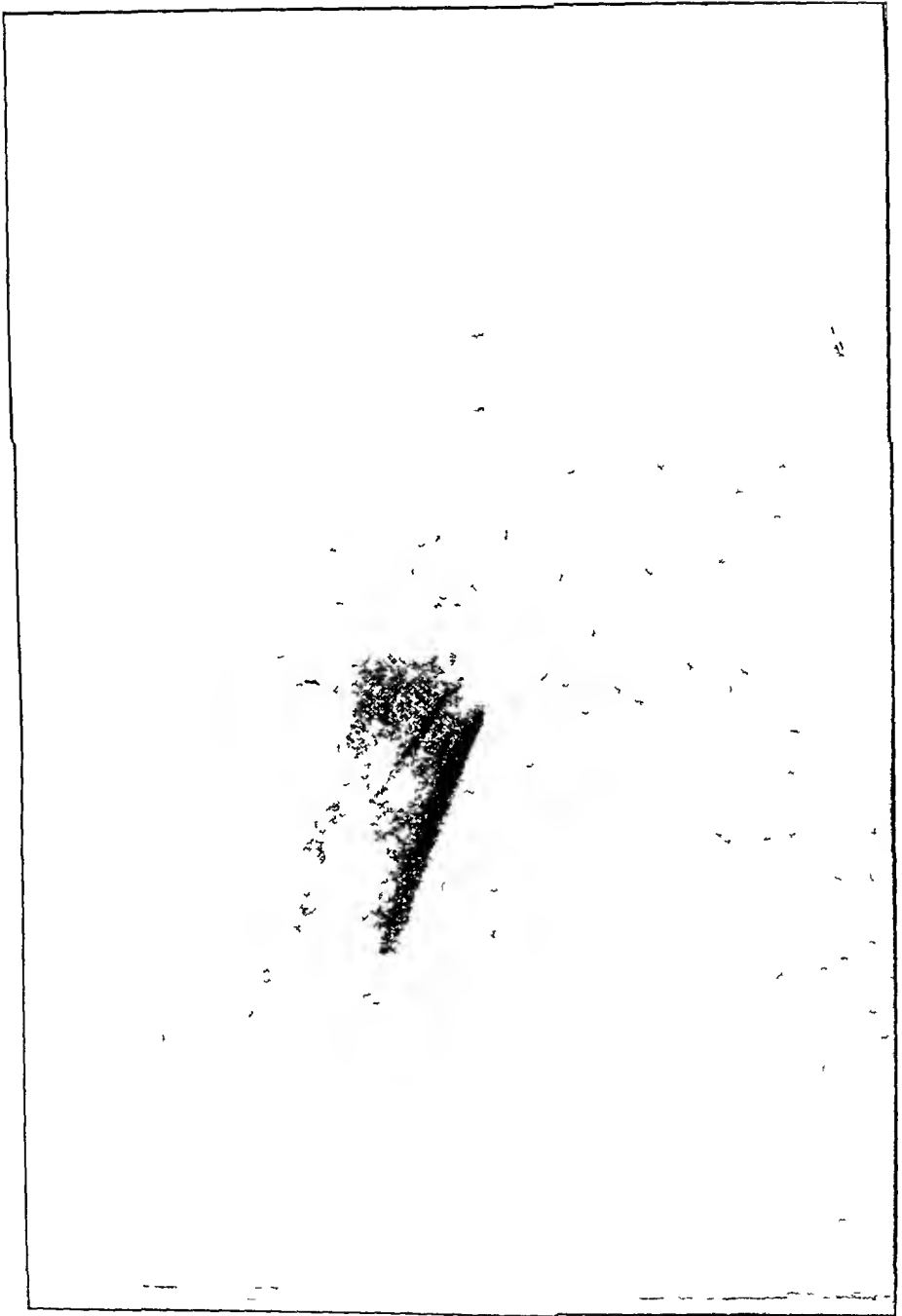
PLATE VII



IMPACTED FRACTURE OF ANATOMICAL NECK OF HUMERUS



PLATE VIII



FRACTURE OF SURGICAL NECK OF HUMERUS





connected with the rest of the bone by a few shreds of capsule, and thus necrosis is prevented. Should impaction occur, the small upper fragment is driven into the lower, and marked deformity of the head of the bone results, which can occasionally be detected by palpation from the axilla. If the articular surface is completely detached, it may be dislocated at the same time, and felt as a distinct fragment in the axilla. Examination must be conducted with great care lest impaction be disturbed, or any capsular attachments broken through, the routine use of skiagraphy in all serious lesions of the shoulder renders such manipulation less necessary than formerly. Repair

takes place mainly from the lower end, and, owing to the difficulty of apposing and immobilizing the fragments, a considerable mass of callus is usually formed. **Treatment**—When there is but little displacement, nothing more is required than to raise the elbow and keep the arm to the side by a suitable bandage, though a comfortable sense of support is given by placing a pad in the axilla. Massage commences early—about the fourth or fifth day—and passive movements a few days later. In the more serious cases a pad or  $\cap$ -shaped splint is placed in the axilla, and retained in position by a soft bandage or handkerchief passing over the top of the shoulder, and tied under the opposite axilla, this assists in raising the arm, which is also supported by an elbow-sling. Finally, a comfortable poroplastic or leather cap is fitted over the shoulder and buckled on. Union generally occurs

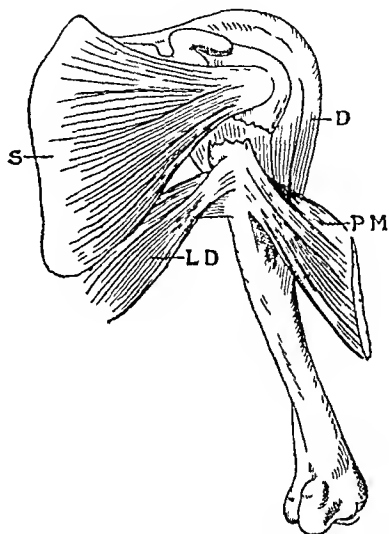


FIG 160—FRACTURE OF SURGICAL NECK OF HUMERUS

S, Subscapularis, LD, latissimus dorsi, D, deltoid, PM, pectoralis major

in about six weeks, but often results in great stiffness, unless massage and manipulation are suitably employed, they must commence, however, a little later than in the simpler cases mentioned above. At first the splints, etc., are restored to position after the daily rubbing, but are gradually discarded, so that by the end of three weeks or so the arm is merely supported by a sling. When the head of the bone has been totally dislocated from the glenoid cavity, operative treatment is often advisable, in some cases the fragment is best excised, but in others an attempt to replace and fix it to the shaft of the humerus should be made, to this end a useful hook for fixing into and manipulating this upper fragment has been devised by McBurney.

2 Fracture of the Surgical Neck, the 'Extracapsular Fracture' (Plate VIII). The bone yields in this case below the muscles attached to the tuberosities, but above the insertions into the bicipital

groove and its margins of the latissimus dorsi, pectoralis major, and teres major. It results from violence applied directly below the point of the shoulder, or from falls on the hand or elbow. The fracture is more or less transverse, and the displacement a double one, the upper fragment is rotated outwards, and generally adducted by the muscles inserted into the tuberosities, especially the subscapularis, whilst the lower fragment is drawn inwards by those attached to the bicipital groove, and upwards by the deltoid, coraco-brachialis, biceps, and triceps (Fig 160). The appearance of the patient is sufficiently characteristic, the head of the bone is still in the glenoid cavity, so that there is no loss of the fulness of the shoulder (Fig 161, C), although there is a depression just below, unless it is obliterated by the extensive hæmorrhagic effusion. The elbow is directed away from the side, and

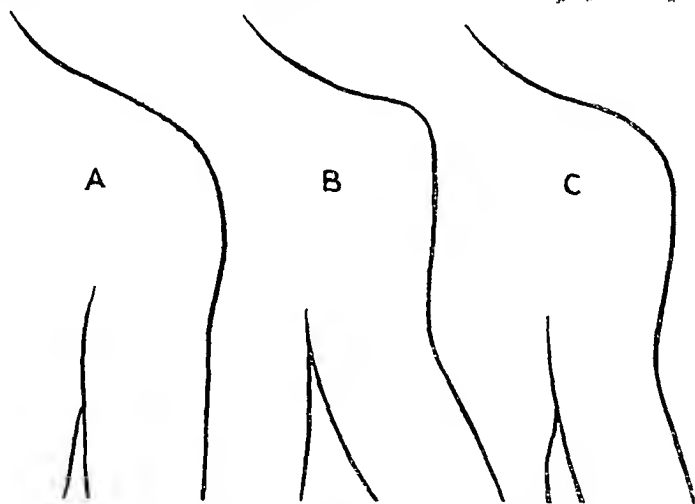


FIG 161 —OUTLINES OF SHOULDER

A, Normal shoulder, B, dislocation of shoulder, C, fracture of surgical neck of humerus

the axis of the lower fragment is upwards and inwards. Crepitus can be obtained by extending and rotating the arm, which is shortened an inch or more. This fracture is often very painful from pressure of the upper end of the lower fragment against the brachial nerves. If impaction occurs, the signs are much less evident, and, indeed, may be very equivocal, the lower fragment is usually driven into the upper, and only slight shortening or displacement may be present.

**Complications**—The axillary vessels may be seriously damaged, or more commonly some of the nerves sustain injury, especially the circumflex, which winds round the neck of the bone close to the site of the fracture.

**Treatment**—Immobilization of the fragments is absolutely necessary in this fracture. It may be secured by the application of an axillary pad and a shoulder-cap, whilst the arm is kept to the side, and the hand supported by a sling. The elbow should be allowed to

hang-to overcome the shortening Middeldorpf's triangle (Fig 163) may be used with advantage in this fracture Firm union usually results in four and a half to six weeks, but with the formation of a good deal of callus, massage and passive manipulations should be daily employed from the third week onwards, the apparatus being taken off for the purpose and re-applied, if necessary

3 Separation of the Upper Epiphysis occurs up to the age of eighteen to twenty years, and involves the head and both the tuberosities The upper end of the shaft is somewhat conical in shape, the apex of the cone fitting into a depression in the middle of the epiphysis (Fig 162) The lesion usually follows the line of the cartilage, but the displacement is often incomplete, partly from the conical projection hitching against the inner edge of the epiphysis (a doubtful occur

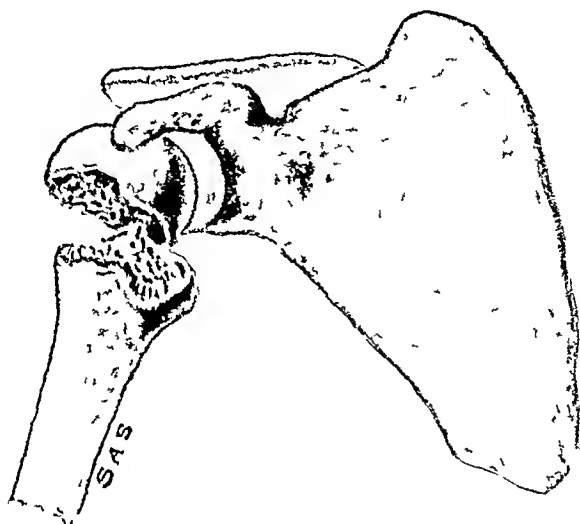


FIG 162—SEPARATION OF THE UPPER EPIPHYSIS OF THE HUMERUS

rence), but mainly from the persistence of a well-marked periosteal sleeve or bridge on the outer and posterior side The shaft usually travels forwards, its upper end projecting so as to be felt or even seen beneath the skin an inch or more below the acromion, occasionally a well-marked inward displacement is superadded, so that the condition somewhat resembles a subcoracoid dislocation The presence of the head of the bone in the glenoid cavity should prevent this mistake, whilst the softness of the crepitus distinguishes it from a fracture

**Treatment**—It is most important to reduce this displacement, since otherwise interference with the growth of the limb is almost certain to ensue This may be effected by traction upon the arm under an anæsthetic, assisted perhaps by slight rotary movements or abduction, but should these manœuvres not be successful, it is quite permissible to open the joint-antiseptically, and restore the parts to their correct position After reduction the limb is treated as for a fracture of the

neck Should union occur in the displaced position, considerable limitation of movement results from the projecting edge of the diaphysis, this may be improved by cutting down and chiselling it away

4 The **Great Tuberosity** is occasionally torn off as a result of direct or muscular violence, or as a complication of fracture through the neck If the whole tuberosity is separated, there is marked deformity, resulting in a great increase in the breadth of the shoulder The fragment is displaced upwards and backwards by the unopposed action of the supra- and infra-spinatus, whilst the shaft of the humerus is drawn forwards and partially dislocated (or subluxated) by the subscapularis and other muscles A distinct sulcus is felt between the two bony masses, and if they can be brought together, crepitus is obtained **Treatment**—There can be no question that when displacement has occurred,

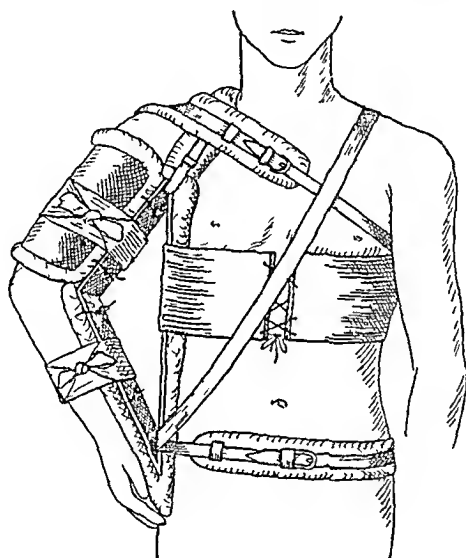


FIG 163 —MIDDELDORPF'S TRIANGLE FOR FRACTURED HUMERUS

For the sake of cleanness, the bandages, etc., have been represented as much smaller than would be the case in the living subject, a Gooch splint may also with advantage be applied to the forearm

the most efficacious plan is to cut down on the fragment and fix it in position by wire, screw, or peg Excellent results follow, if asepsis is maintained Failing operative treatment, the patient must be kept in bed, with the arm elevated and extended, supported by pillows—a most uncomfortable position—until union has occurred Failing an accurate diagnosis, the case will probably be treated by applying an axillary pad and keeping the elbow to the side, the fragment cannot be approximated in this way, and the result will be defective union and a weak arm, which often remains permanently crippled in spite of massage and galvanism

**Fractures of the Shaft of the Humerus** may arise from any form of violence, whether direct or indirect, and even from muscular violence,

as, *e.g.*, in throwing a cricket-ball. The signs of the injury are very obvious, and most typical. The displacement depends largely on the position of the fracture. If it occurs above the insertion of the deltoid, but below that of the muscles inserted into or around the bicipital groove, the upper fragment is drawn inwards, and the lower upwards and outwards. If, however, it is below the deltoid, the upper fragment is drawn outwards, and the lower upwards and inwards. As the line of fracture approaches the elbow, the displacement tends to become more antero-posterior than lateral, owing to the change in shape of the bone. The most common complication is injury to the musculo-spiral nerve which winds round the shaft close to its centre.

**Treatment**—An internal angular splint reaching from the axilla to the wrist must be applied, together with three small lateral splints to fix the fragments, or a piece of Gooch or kettle-holder splint, the limb is kept to the side in a sling. Union is usually complete in five weeks.

It is not at all uncommon to meet with an ununited fracture of the shaft of this bone, this is probably due, not to any anatomical reasons, but simply to the fact that the necessity for fixing and supporting the elbow-joint has not been appreciated, the fore-arm being allowed to hang loose on the false plea of tending to diminish the shortening.

A very useful appliance for all fractures of the humerus is the Middeldorpf triangle (Fig 163). It is carefully padded so that the angles and edges are protected, and applied so that its base is in contact with the body-wall and its obtuse-angled apex in the elbow. It is fixed by a strap or bandage passed from the axillary angle over the same shoulder and under the opposite axilla, as also by a sheet or bandage round the trunk. Pieces of Gooch splinting can be applied to the arm, thus completely immobilizing the humerus, and the fore-arm is also fixed. The fingers are left free, or if there is any swelling they are bandaged. This apparatus is even more efficacious when the patient is standing than when he is recumbent.

**Fractures of the Lower End of the Humerus**—In dealing with any injury in the vicinity of the elbow, it is absolutely essential that the relative position of the bony points, which can there be felt, should be accurately established, and a comparison made with those of the opposite side. Normally four bony prominences can be detected, viz, the two condyles, the olecranon, and the head of the radius. The relation of the olecranon to the condyles varies with the position of the elbow. If the fore arm is extended, the tip of the olecranon just touches the intercondyloid line, but is placed nearer the inner than the outer condyle, whilst in flexion of the fore-arm it lies below that line. The head of the radius in all positions of the arm is immediately below the outer condyle, and can be felt rotating beneath a dimple in the skin which appears at that spot. When the arm is flexed to a right angle, the tip of the olecranon is a little in front of the posterior surface of the upper arm, so that a ruler placed along that surface misses the olecranon, this is a useful guide in ascertaining if the bones of the fore-arm have been displaced backwards or forwards.

Another important feature depends on the fact that the axis of the

fore-arm does not correspond with that of the arm, the former being in a position of slight abduction (about  $15^{\circ}$ ), constituting what is known as the 'carrying angle' (Fig 164, A) Lateral deviation following fractures in the neighbourhood of the elbow results in modifications of this angle, and if these are allowed to persist, conditions of cubitus varus or valgus (Fig 164, B, C) ensue, which much interfere with the utility of the limb

I **Transverse Supracondylar Fracture**, involving the shaft about 1 or 2 inches above the joint, is due either to a fall on the hand with the arm bent, when the lower fragment is usually displaced backwards, or much less commonly to a fall on or violence directed to the point of the elbow, when the displacement is either forwards or back

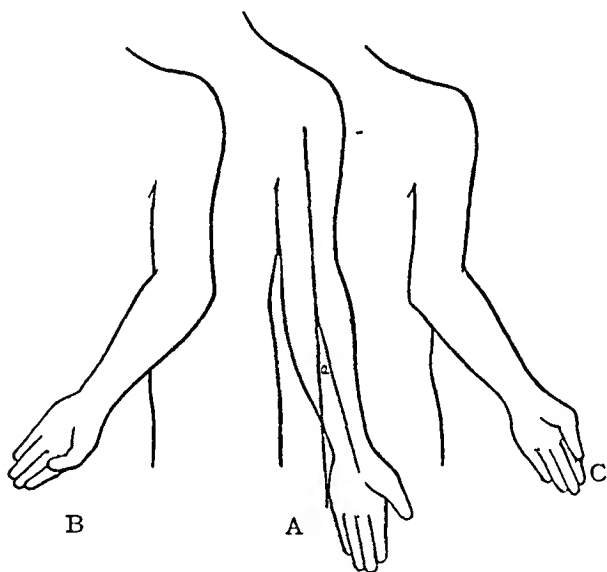


FIG 164—OUTLINES OF UPPER EXTREMITY TO SHOW A, NORMAL CARRYING ANGLE ( $a = 15^{\circ}$ ) B, CUBITUS VARUS C, CUBITUS VALGUS

wards When the lower fragment is displaced backwards, it is also drawn up by the action of the triceps upon the olecranon, a certain amount of angular as well as vertical deformity being thus produced, when displaced forwards, apparent lengthening of the fore-arm results, with a loss of prominence of the olecranon The former of these conditions is likely to be mistaken for a dislocation of both bones backwards at the elbow (*cf* Fig 165, A and B), but may be recognised by the following facts (a) The relative position of the bony points at the elbow is unimpaired, in a dislocation they are necessarily disturbed (b) The length of the arm measured from a tubercle which can be easily felt at the back of the acromion to the outer condyle is diminished in a fracture, but remains unaltered in a dislocation (c) The forward projection of the lower end of the upper fragment is felt above the crease of the joint, whilst in a dislocation it corresponds with it (d) The deformity is easily reduced

with crepitus, but readily reappears, in a dislocation the bones are replaced with difficulty, but after replacement they usually remain in position. It may be difficult and at times almost impossible to recognise this condition at once, owing to the amount of swelling and ecchymosis present, the application of a cooling lotion for a few days will so reduce this as to permit a thorough examination, and this is most essential, as a wrong diagnosis probably leads to bad treatment and much subsequent impairment of function of the limb. Skiagraphy will, however, determine the nature of the lesion without delay. Lateral deviation sometimes occurs, and the restoration of the normal 'carrying angle' must always be aimed at.

Much care is needed in the **Treatment** of these cases in order to prevent ankylosis or deformity, and the stereotyped application of an

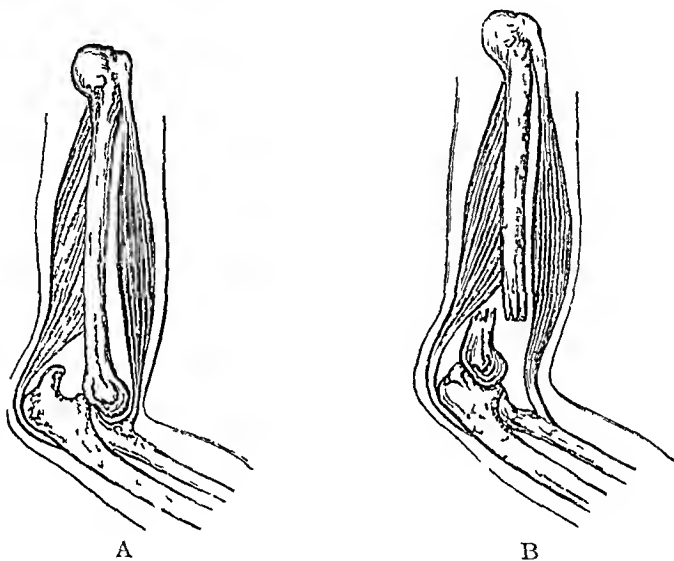


FIG 165 —FRACTURE OF LOWER END OF HUMERUS (B) COMPARED WITH DISLOCATION OF RADIUS AND ULNA BACKWARDS AT ELBOW (A) (TILLMANN'S)

internal angular splint is by no means sufficient. To correct the backward deformity the elbow must be flexed, and traction made upon the fore arm, which is placed in a position of full supination. It may then suffice to apply an anterior angular splint in the bend of the elbow, and a straight posterior splint reaching below the tip of the olecranon, so as to keep it well forwards, or perhaps it would be better to apply a carefully-moulded gutter-shaped posterior splint reaching well above and below the elbow, and a shorter anterior splint fitting down to the bend of the joint. In these fractures the elbow-joint is not as a rule involved, and therefore passive movement is not commenced too early for fear of deformity, owing to yielding of the callus. At the same time, it must not be delayed too long, as if the olecranon and coronoid fossæ are involved, they become occupied by callus, and if this is allowed to consolidate, the movements of the



arm will be subsequently limited. In displacements of the bone forwards an anterior angular splint should be employed, and possibly a short posterior one in addition.

2 **Separation of the Lower Epiphysis of the Humerus** is a very common accident in children. At birth and for some years afterwards the epiphysis consists of a single mass of cartilage, including the two condyles as well as the articular surface, and these are all involved in any separation, together possibly with a fragment of the diaphysis (Fig 166). As, however, growth and ossification proceed, the shaft encroaches rapidly upon the inner portion of the epiphysis, so that the

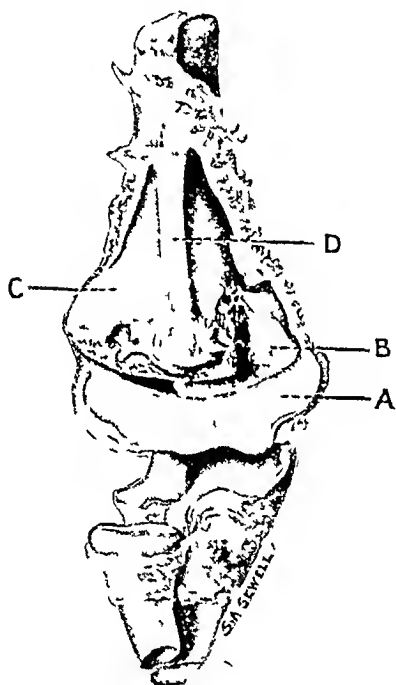


FIG 166 —SEPARATION OF THE LOWER EPIPHYSIS OF THE HUMERUS IN AN INFANT UNDER THREE YEARS (MUSEUM OF ROYAL COLLEGE OF SURGEONS)

A Epiphysis, including both condyles, B, small portion of the diaphysis detached with epiphysis, C, diaphysis, D, loose periosteal bridge

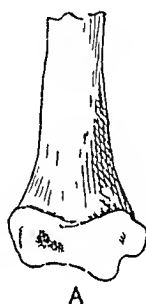
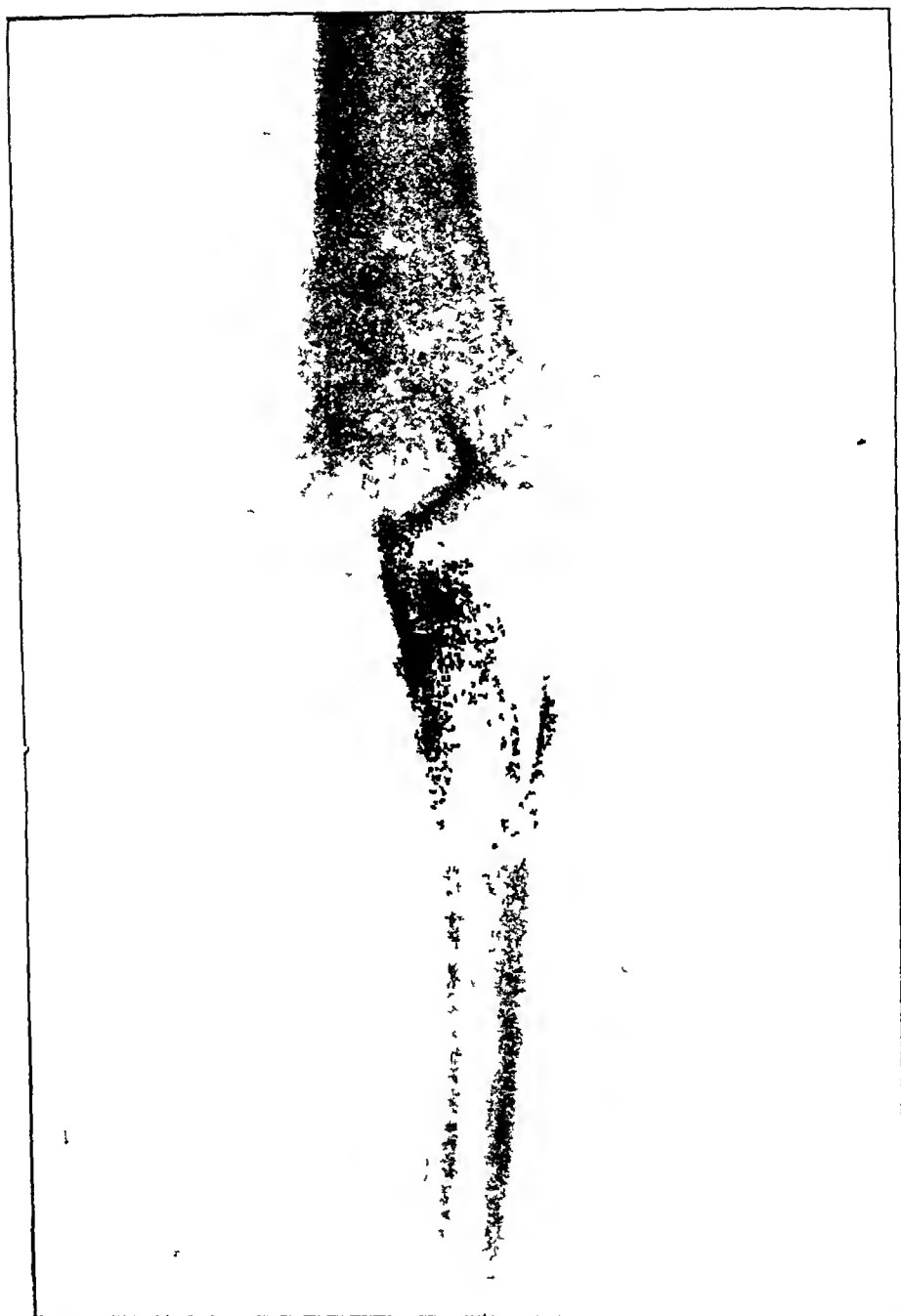


FIG 167 —A AND B, LOWER END OF THE HUMERUS AT THREE YEARS AND FIFTEEN YEARS OF AGE (SEMI-DIAGRAMMATIC AFTER QUAIN'S ANATOMY)

In A there is only one centre of ossification, in B all the centres in the lower epiphysis have joined together with the exception of that for the internal condyle

epiphyseal line becomes almost rectangular (Fig 167), the internal condyle being isolated from the rest of the epiphysis. As a result of this, separations of the epiphysis after puberty do not include the internal condyle, the accident at this period is situated relatively much nearer the joint than in infants, and consequently is more likely to be followed by impairment of movement. The displacement is

# PLATE IX



SEPARATION OF THE LOWER EPIPHYSIS OF THE HUMERUS, WITH DISPLACEMENT OUTWARDS IN A YOUNG PERSON A LITTLE OVER THE AGE OF PUBERTY

The outer condyle has been broken off as well as the epiphysis and displaced upwards and outwards, above this fragment is seen a shadow caused by the stripping up of the periosteum. The ulna and radius accompany the lower epiphysis of the humerus outwards.



generally backwards, with some amount of lateral displacement or deviation (Plate IX) **Treatment**—Reduction can usually be accomplished by flexion, and the application of antero posterior splints may suffice to maintain the fragment in position, but it is an open question whether it is not wiser, at any rate in small children, to avoid splints and trust to full and complete flexion alone, the hand being bandaged down to the shoulder on the same side. Passive movements should commence from about the eighth day.

3 Fracture of the **Condyles** usually results from direct injury, though the outer is sometimes broken by indirect violence, such as a fall on the hand, since the laxity of the elbow-joint on this side allows considerable mobility between the radial head and the capitellum of the humerus. Fracture of the **external condyle** always involves the elbow-joint, and is more common than that of the inner.

The line of fracture runs from the condylar ridge downwards and inwards so as to separate the capitellum, or even encroach upon the trochlear surface. The fragment is but little displaced, and can be felt to move on the rest of the bone with crepitus, which may also be produced by rotation of the hand and radius. The accident is associated with much pain and ecchymosis. Fracture of the **internal condyle** may be intra- or extra-capsular. The *extra-articular* variety (Fig 168) consists of a mere displacement of the tip of the condyle (or epicondyle), probably a separation of the epiphysis, since it occurs mainly in children. The small fragment is drawn a little downwards by the muscles attached to it, and the fracture is readily detected by the usual signs, it may be associated with injury of the ulnar nerve. The *intra-articular* form is the more common, and extends from the condylar ridge to the trochlear surface, implicating the coronoid and olecranon fossæ. The fragment is displaced a little upwards and backwards, the ulna usually accompanying it, so that on extending the elbow the olecranon appears unduly prominent, the lower end of the humerus projects anteriorly, and the fore-arm is slightly adducted (cubitus varus). The ulnar nerve may also be injured in this case.

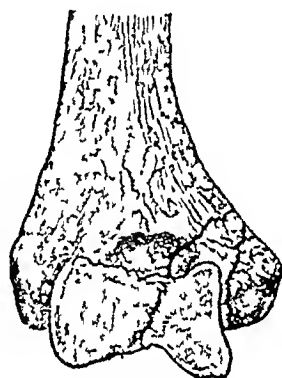


FIG 168 -- FRACTURE OF INTERNAL CONDYLL AND EPICONDYLE OF HUMERUS (ILL-MANN)

**Treatment**—Flex the fore-arm and place it on an angular splint, using a pad and strapping to maintain the fragments in position. If the joint has been involved, passive movement should be started early to avoid subsequent stiffness. Possibly in some cases it would be wiser to apply no splints, and treat the fracture by early massage, whilst in others it may be better to operate and fix the fragment by wire or screw.

4 **T- or Y-shaped Fracture** usually occurs as the result of direct injury. A fissure extends into the joint between the condyles, and

may bifurcate above so as to detach partially or completely the two condyles, or it may be connected with a transverse supracondylar fissure, constituting the T-shaped variety. If the fragments are not totally detached, there will be much bruising and pain, but no crepitus, but if the fragments are separated, the condyles will move on each other with crepitus, and the elbow will be widened with much deformity. In these cases the joint is very likely to become stiff, owing not only to adhesions within it, but also to the filling up of the fossæ in the lower end of the humerus with callus. Excess of violence leads to comminution, and luxation of the bones of the fore-arm may also occur. A marked feature of these cases is the rapidity with which swelling supervenes, owing to hæmorrhage into and around the joint, rendering accurate diagnosis difficult apart from skiagraphy. **Treatment** must be directed towards reducing the swelling, and then, after manipulating the fragments into as good a position as possible, antero-posterior angular splints are applied, and passive motion started early. In some cases incision and fixation of the fragments are indicated, in others excision of the end of the bone.

**Fractures of the Ulna**—The **Olecranon** is frequently broken by direct violence, the patient falling on the bent elbow, but occasionally by muscular action. The line of fracture usually runs through the base of the process at its attachment to the shaft, and is for the most part transverse. Should the tendinous and periosteal coverings of the bone remain intact, there is but little separation, but if the fracture is complete, the detached fragment is drawn up by the triceps and tilted backwards (Plate X), whilst the bones of the fore-arm are subluxated forwards. Great swelling in and around the joint comes on early, on examination, the detached fragment can be readily distinguished, and between it and the shaft a sulcus, which increases on flexing and diminishes on extending the fore-arm. The nature of the union depends on the amount of separation of the fragments, and the treatment adopted. If the fragments are not brought accurately into apposition, fibrous union will occur, and although the new cicatricial tissue may stretch considerably, a useful elbow sometimes results, in some cases the fragment is drawn up and fixed to the humerus, and a false joint is developed below it. If, however, the fragments are brought in contact, bony union follows, though even then some impairment of function may ensue owing to the callus encroaching on the articular surface, which is always involved. In all cases the ulnar nerve is exposed to injury.

**Treatment**—The most satisfactory plan consists in laying the parts freely open, clearing the joint of all blood-clot, removing shreds of tendon which may be placed between the fragments, and then wiring them together, the wire just extending down to the articular cartilage (Plate XI). The same precautions and after-treatment must be followed as in dealing with the patella. A similar plan should be adopted in all compound cases, and in those where loose fibrous union has occurred with a resulting weak and relaxed elbow, in the latter instance the new fibrous tissue must be entirely dis-

PLATE X



FRACTURE OF OLECRANON BEFORE OPERATION



## PLATE XI



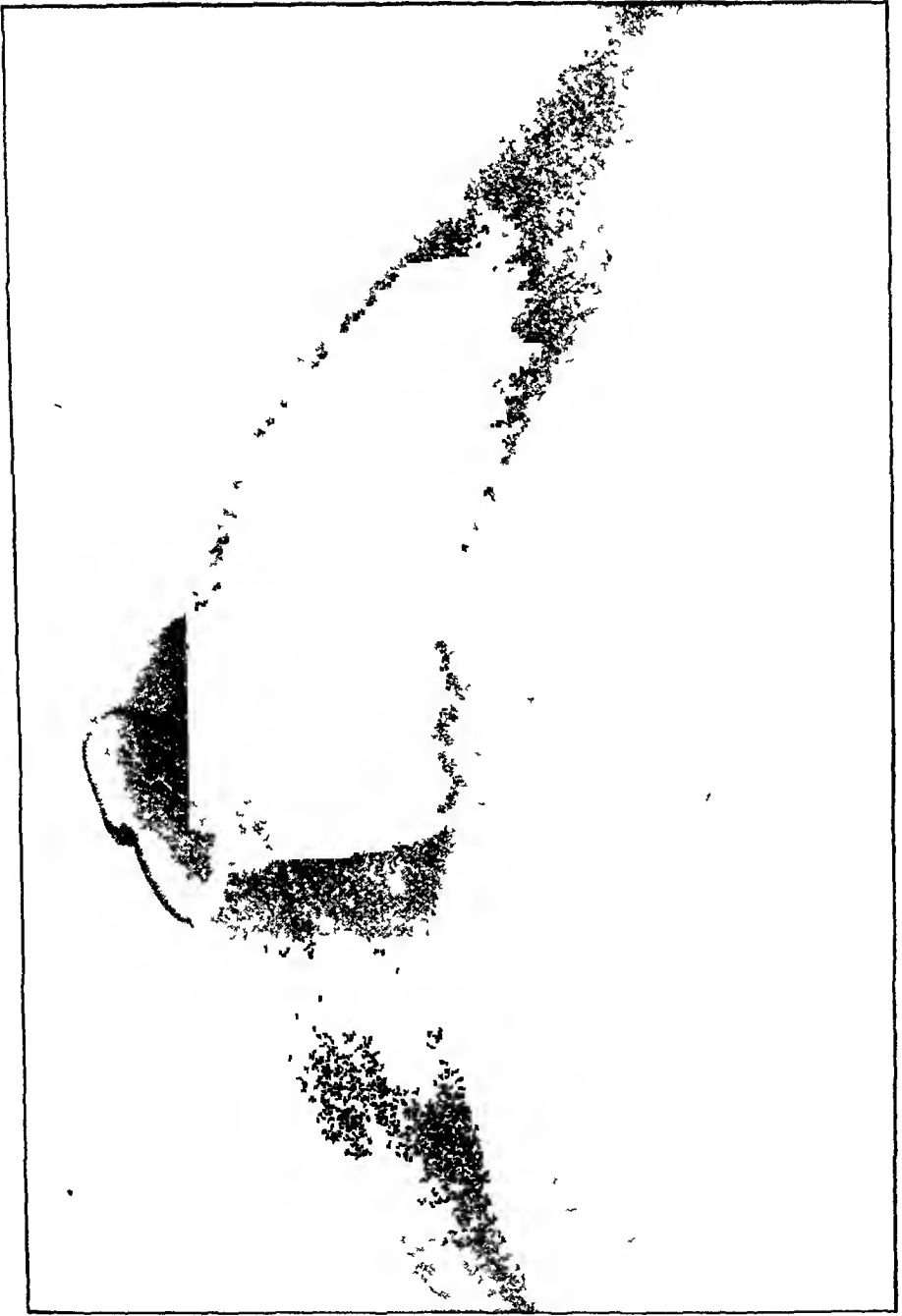
### FRACTURE OF OLECRANON TWO WEEKS AFTER OPERATION

From the same patient as Plate X It will be noted that, though the fragments are in apposition, they are not united





## PLATE XII



FRACTURE OF OLECRANON (SIX WEEKS AFTER OPERATION)  
From the same patient as Plates X and XI The fragments are now united  
by bone



sected away and the bony surfaces freshened. If an operation is not undertaken, the arm should be put up on a straight anterior splint, the fragment being drawn into position as well as possible by means of a pad and figure-of-8 bandage. Gentle passive movement and massage should commence at the end of a fortnight.

2 The **Coronoid Process** is so deeply placed and so well protected that fractures must necessarily be very uncommon, except as an accompaniment of dislocation of the ulna backwards. The signs relied on in making a diagnosis are that reduction of the dislocation is easier than usual and associated with crepitus, and that the deformity is likely to recur. The **Treatment** consists in apposing the bony surfaces, if possible, by flexing the fore-arm. Bony union is, however, less important than a freely moveable elbow, and therefore passive movement is commenced early.

3 The **Shaft of the Ulna** is often fractured by itself as a result of direct violence, to which its exposed position renders it peculiarly liable. Fracture also occurs as a complication of several of the forms of dislocation of the radius alone (Plate XXVIII). The superficial position of the posterior border renders examination of the bone easy; if displacement or a breach of substance occurs, it is readily detected, but when merely a fissure exists, it is not so easy to make out. The constant pain referred to one spot, the slight mobility, and possibly crepitus, indicate the character of the lesion. No longitudinal displacement can occur if the radius remains intact, and under such circumstances the only deformity consists in a slight drawing forwards of the upper fragment by the brachialis anticus, whilst the lower fragment is approximated to the radius by the pronator quadratus. **Treatment**—The arm is placed midway between pronation and supination, the deformity corrected, and the limb kept at rest between anterior and posterior splints, or in plaster of Paris.

4 The **Styloid Process** may be detached by direct violence, or as a complication of fracture of the lower end of the radius. The displacement may be considerable and very evident, being governed by the direction of the violence. **Treatment** consists in replacing the fragment by manipulation, and fixing it by adhesive plaster, an anterior splint is applied with the hand adducted.

**Fractures of the Radius**—1 The **Head of the Radius** may be broken alone, but more usually such an accident is associated with other injuries to the elbow, as, for instance, fracture of the outer condyle or some form of dislocation. The upper epiphysis may be separated, or there may be merely a transverse or vertical fissure, but under any circumstances the displacement is slight if the orbicular ligament remains intact. In complete separation the head is immovable, and crepitus is produced when the arm is rotated, bony union usually follows, with more or less impairment of function, but sometimes the head, or a portion of it, remains detached as a loose body in the joint. **Treatment**—The limb must be kept at rest for a short time midway between pronation and supination, and early

passive movement instituted. Excision of the head may be required for comminution, or for limitation of movement due to excessive formation of callus.

2 The Neck, *i.e.*, the portion between the orbicular ligament and the biceps tuberosity, is occasionally broken. The lower fragment is drawn upwards and forwards by the biceps, causing a bony projection on the front of the elbow, especially evident on attempting to flex the joint, whilst the fore-arm is pronated with loss of the power of rotation, and the head of the bone does not accompany the shaft on passively rotating it. **Treatment**—The arm is flexed to relax the biceps and supinated, and the limb placed on a posterior angular splint, with a pad over the front of the lower fragment. Passive movement should not be commenced too early, as the lesion is extra-articular, and the biceps may produce permanent deformity if allowed to act upon unconsolidated callus.

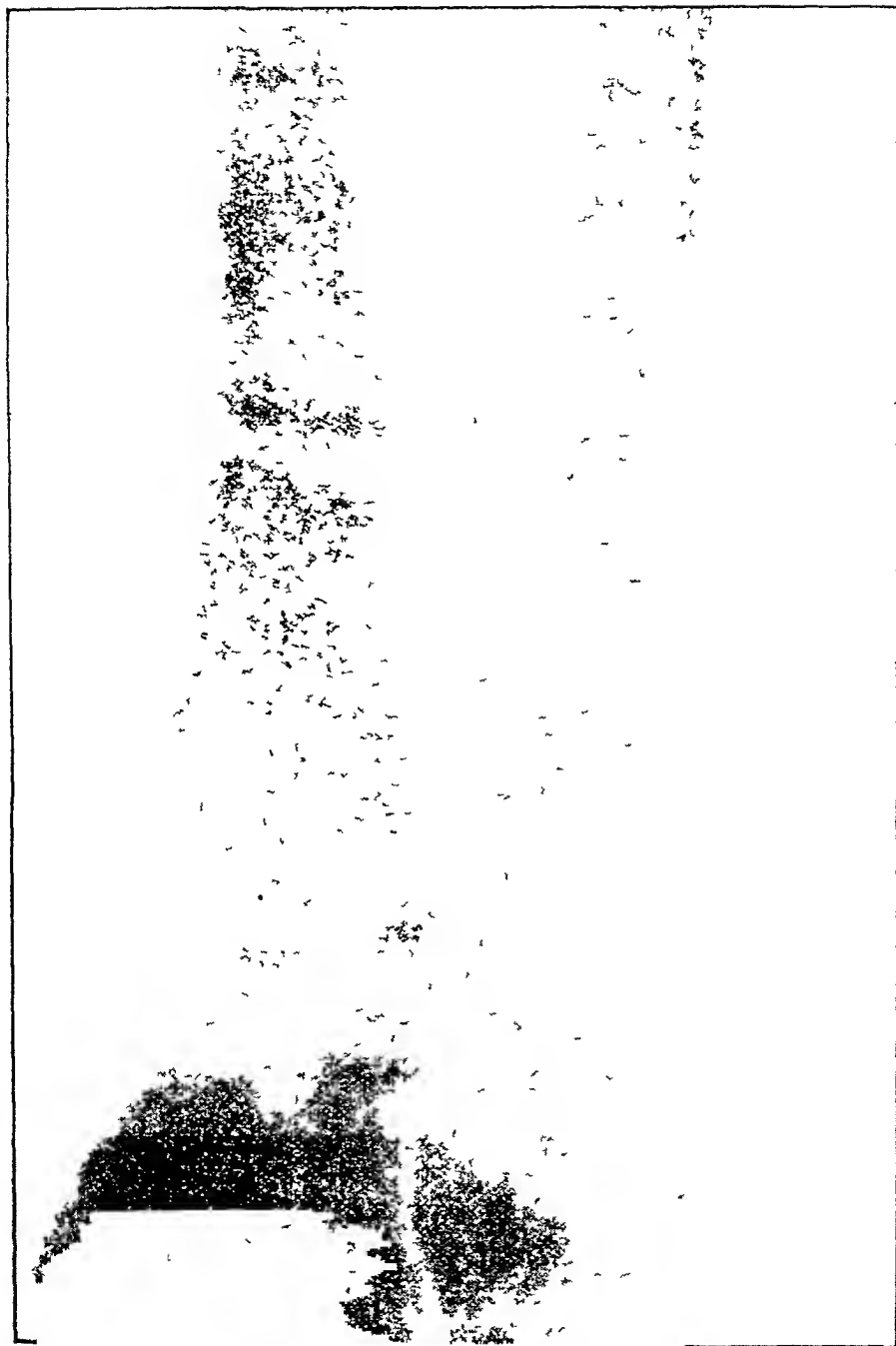
3 The Shaft of the radius is broken either by direct violence or by falls on the palm, the latter accident, however, rarely causes fracture except at the lower end. The signs are sufficiently evident, owing to the superficial position of the bone, consisting of localized pain and loss of power of active rotation, whilst passive rotary movements are accompanied by crepitus, the head of the bone and upper fragment remaining immobile below the outer condyle unless impaction is present.

The *displacement* is somewhat characteristic. If the fracture is situated *above the insertion of the pronator teres*, the upper fragment is flexed and fully supinated by the action of the biceps and supinator brevis, whilst the lower fragment is drawn towards the ulna and fully pronated by the unopposed action of the two pronator muscles. **Treatment**—Inasmuch as it is practically impossible to command the small upper fragment, the lower must be brought into apposition with it by fully supinating the fore-arm and hand after flexing the elbow, and applying a posterior splint, the patient being preferably kept in bed for a time and the arm laid on pillows. It may afterwards be supported in a hollow leather splint carried across the body, and with the palm directed upwards.

When the fracture is placed *below the insertion of the pronator teres*, the upper fragment is drawn forwards by the action of the biceps, and inwards by the pronator, assuming a position midway between pronation and supination, the lower fragment is approximated to the ulna partly by the direct action of the pronator quadratus, partly by the supinator longus tilting the upper end inwards, the hand is fully pronated looking downwards. Union to the ulna by callus thrown across the interosseous space is not unlikely to occur. **Treatment** by anterior and posterior splints may here be adopted, with a good interosseous pad interposed between the limb and the splints, the arm being placed midway between pronation and supination, and the hand fully adducted.

4 The Lower End of the Radius is broken with extreme frequency, constituting what is known as Colles's Fracture. This injury occurs

PLATE XIII



FRACTURE OF SHAFT OF RADIUS (ANTERO POSTERIOR VIEW)



PLATE XIV



FRACTURE OF SHAFT OF RADIUS (LATERAL VIEW)

From the same patient as Plate XIII, and showing excellently the necessity for taking skiagraphs from two points of view





PLATE XV



COLLES'S FRACTURE A SIMPLE CASE, WITHOUT MUCH LATERAL DISPLACEMENT OF HAND



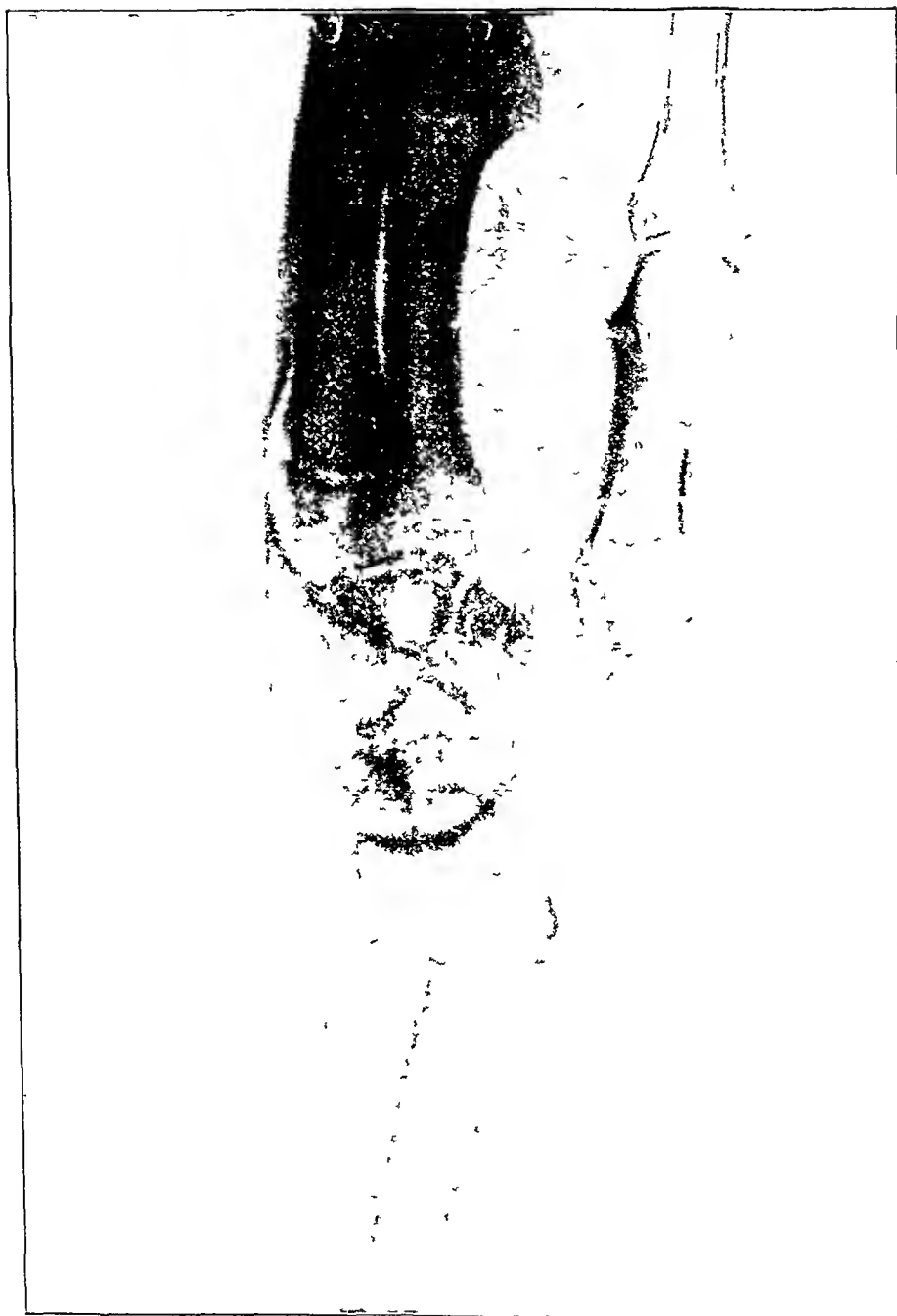
PLATE XVI



COLLES'S FRACTURE A BAD CASE, WITH THE STYLOID PROCESS OF THE ULNA  
TORN OFF AND MUCH OUTWARD DISPLACEMENT OF HAND



PLATE XVII



LATERAL VIEW OF COLLES'S FRACTURE, SHOWING DISPLACEMENT BACKWARDS  
AND UPWARDS OF THE LOWER FRAGMENT



most commonly in women of advanced years, although it may happen at any age or to either sex. It is almost invariably due to falls upon the outstretched palm, when the hand is completely pronated and extended. The line of fracture is placed about 1 inch from the wrist, though rather under than over this. It is usually transverse, but occasionally oblique in an antero-posterior direction, sloping from above downwards and forwards, so that the fracture is nearer the wrist-joint in front than it is behind, and also not uncommonly oblique laterally, slanting from without downwards and inwards (Plate XV).

The displacement is somewhat complicated. (a) The lower fragment is carried backwards and a little upwards (Plate XVII), a condition resulting from the direction of the violence, viz, a fall on the palm of the outstretched hand, the radius being thus compressed between the ground and the weight of the body, and yielding at what is evidently a weak spot, this deformity is maintained by the action of the radial extensor muscles of the wrist, and often by impaction of the fragments. (b) From the fact that the main violence is received by the ball of the thumb, owing to the extreme pronation of the hand, the outer side of the lower fragment is displaced more than the inner, which, moreover, remains fixed to the ulna by the strong inferior radio-ulnar ligaments. This position is in part kept up by the tension of the extensors of the thumb and the supinator longus, but mainly by impaction of the fragments. The hand and carpus always follow the lower fragment, and hence the former becomes markedly abducted, causing the styloid process of the ulna to become unduly prominent, and lower than that of the radius, whereas it is normally placed on a slightly higher level. In bad cases the styloid process of the ulna is actually torn off, or the internal lateral ligament ruptured, allowing displacement outwards of the whole hand (Plate XVI). (c) The lower fragment is also rotated around a transverse axis, so that the lower articular surface looks backwards as well as downwards, a displacement due to the fact that in falling the force is directed, through the carpus, more to the posterior than to the anterior aspect of the bone. (d) The upper fragment is pronated and approximated to the ulna by the pronator quadratus muscle. The deformity produced by the fracture is therefore very characteristic. The hand is in a position of radial abduction, and usually pronated, with the fingers somewhat flexed (dinner-fork deformity). Three abnormal osseous projections are present. (i) The styloid process or head of the ulna is very marked, owing to the radial abduction of the hand (Fig. 170), (ii) on the back of the wrist is a prominence which terminates abruptly above, caused by the projection of the lower fragment (Fig. 169), and (iii) corresponding to this dorsal projection there is a well-marked depression on the palmar surface, and above it a less sharply-defined swelling, which gradually shelves into the fore arm, due to the upper fragment. Pronation and supination are lost, and, as a rule, there is neither crepitus nor preternatural mobility, owing to impaction of the fragments. In doubtful cases help in diagnosis may be obtained by



observing the relative position of the two styloid processes, normally, that of the radius is well below that of the ulna, but in cases of fracture the ulnar projection is below that of the radius

As already stated, the fracture is commonly impacted, the upper fragment being firmly driven into the cancellous tissue of the lower end, excess of violence may, however, disimpact, but often at the expense of comminution of the lower fragment. Union is effected without difficulty, but the patient should always be warned at an early date to expect some deformity about the wrist, as well as considerable impairment in the subsequent mobility of the fingers and hand, owing partly to adhesions in the joint, partly to blood trickling down the tendon sheaths and fixing the tendons

**Treatment** —To reduce the deformity, extension and manipulation are both needed. The patient should be seated on a chair, and the

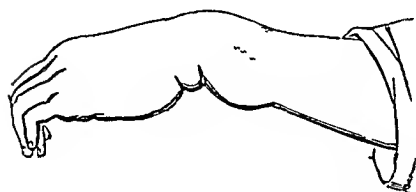


FIG 169 —COLLES'S FRACTURE  
LATERAL VIEW

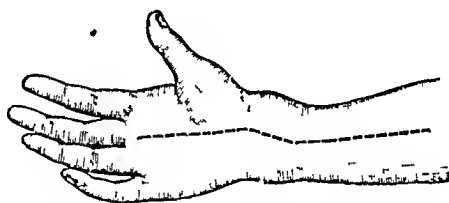


FIG 170 —COLLES'S FRACTURE  
PALMAR VIEW (TILLMANN'S)

surgeon, standing in front, should grasp the hand firmly, using the right hand for fractures on the right side, and the left for those on that side. Counter-extension is made from the flexed elbow, and the hand is then forcibly extended and adducted, disimpaction is thus brought about and a little manipulation enables the fragments to be moulded into position

Many plans have been adopted in the application of splints for this fracture (1) A piece of *Gooch's splint* is perhaps the most simple and efficacious. It is shaped so as to cover the radius front and back as far as the middle line of the arm, and extends nearly from the elbow to the front and back of the knuckles of the index and middle fingers. Its lower end is hollowed out in a horseshoe manner, so as not to reach beyond the end of the metacarpal bone of the thumb. This is well padded and firmly bandaged on, it grasps the radius and steadies the hand in a position of adduction, without in any way interfering with the movements of the fingers. (2) *Carr's splint* (Fig 171) consists of two shaped pieces of wood fitting the front and back of the radial side of the fore-arm, whilst to the palmar one is attached an oblique rod to be grasped by the fingers, and thus the hand and wrist are maintained in a position of adduction, whilst the fingers can be freely moved. (3) The *Pistol splint* consists of a straight portion fitted to the front of the fore-arm, whilst the hand piece is bent at an angle like the butt-end of a pistol. It may also be applied to the back of the fore-arm, together with a short straight splint on the palmar aspect reaching to the wrist. It keeps the

hand and arm in excellent position, but is objectionable because the fingers are also restrained. If, however, it is shortened at the end of four or five days so as not to extend beyond the knuckles, it may be used without doing harm. (4) Two straight splints may be applied to the front and back of the fore-arm, which is kept midway between pronation and supination, neither should extend beyond the knuckles, so that the fingers are free. The weight of the hand, when the arm is slung, keeps it in a position of adduction.

Union is usually firm enough in a fortnight to permit the removal of the splints, the arm being kept in a leather or gutta-percha support for some time longer. Massage and passive movement should be employed after the first week, and the fingers left free and exercised after the first day or two.

5 **Separation of the Lower Epiphysis** of the radius occurs in young people under twenty, and, when the lower fragment is displaced backwards, simulates somewhat closely a Colles's fracture. The lower end of the diaphysis projects anteriorly to a much greater

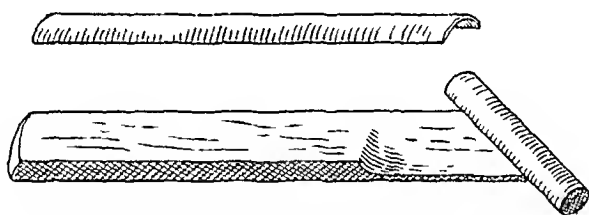


FIG 171 —CARR'S SPLINT FOR COLLES'S FRACTURE OF LEFT HAND

extent, and, indeed, may protrude through the skin of the wrist. The lower end of the ulna may be involved in the accident, either the epiphysis being separated, or the shaft broken a little above. This condition may be mistaken for a backward dislocation of the wrist, but a diagnosis can be readily made by observing the relative position of the styloid processes to the carpal bones. Lateral displacement occurs in some cases (Fig 172). **Treatment** is practically the same as for Colles's fracture.

Should arrest of growth result from this accident, the hand retains its connection with the stunted radius, but the ulna continues to grow downwards, and its lower end is found on the inner and posterior aspect of the carpus, which is pushed *en bloc* towards the radial side, but without any marked abduction.

**Fracture of both Bones of the Fore-arm** may result from direct or indirect violence, but more commonly from the former. Any part of the bones may yield, but the middle and lower thirds are most frequently affected, owing to their greater exposure. The line of fracture may be transverse or oblique, and the displacement varies both with this and with the force employed. Occasionally both bones are broken close to the wrist by a fall on the palm of the

hand (Plate XVIII) The upper fragments are usually drawn together and pronated, whilst the lower end of the radius is drawn up by the supinator longus The diagnosis of these fractures is very simple, since there is, as a rule, obvious deformity **Treatment** consists in reduction by extension conjoined with manipulation, and the application of splints which will prevent cross-union of the bones If the fracture is above the insertion of the pronator teres, the arm must be put up in full supination, as suggested for a similar fracture of the radius alone (p 512), whilst below that spot the usual position midway between pronation and supination may be allowed Union is generally complete in five or six weeks



FIG 172 —SKIA-GRAM OF DISPLACEMENT OF LOWER EPIPHYSIS OF RADIUS AND OF THE HAND OUTWARDS

**Fractures of the Metacarpal Bones and Phalanges** are not uncommon, particularly in the third and fourth fingers, being due to direct violence, and hence usually transverse There is generally but little displacement, though occasionally the fragments may overlap, whilst a certain amount of localized swelling and tenderness is always noted The treatment usually required is immobilization for a short time, and for the phalanges a small zinc splint moulded along the front of the finger acts admirably Should the fragments overlap, operation may be necessary (see Plates XIX and XX)

Bennett, of Dublin, has described an interesting fracture of the first metacarpal (*stave of the thumb*), which is due to indirect violence, and not very rare The line of fracture is oblique, separating the anterior portion of the base, which remains *in situ*, from the rest of the shaft, which is drawn upwards and backwards, so as to lie behind the trapezium Should the displacement be overlooked, the bone unites in

PLATE XVIII



FRACTURE OF BOTH BONES OF THE FORE ARM, WITH DISPLACEMENT OUTWARDS



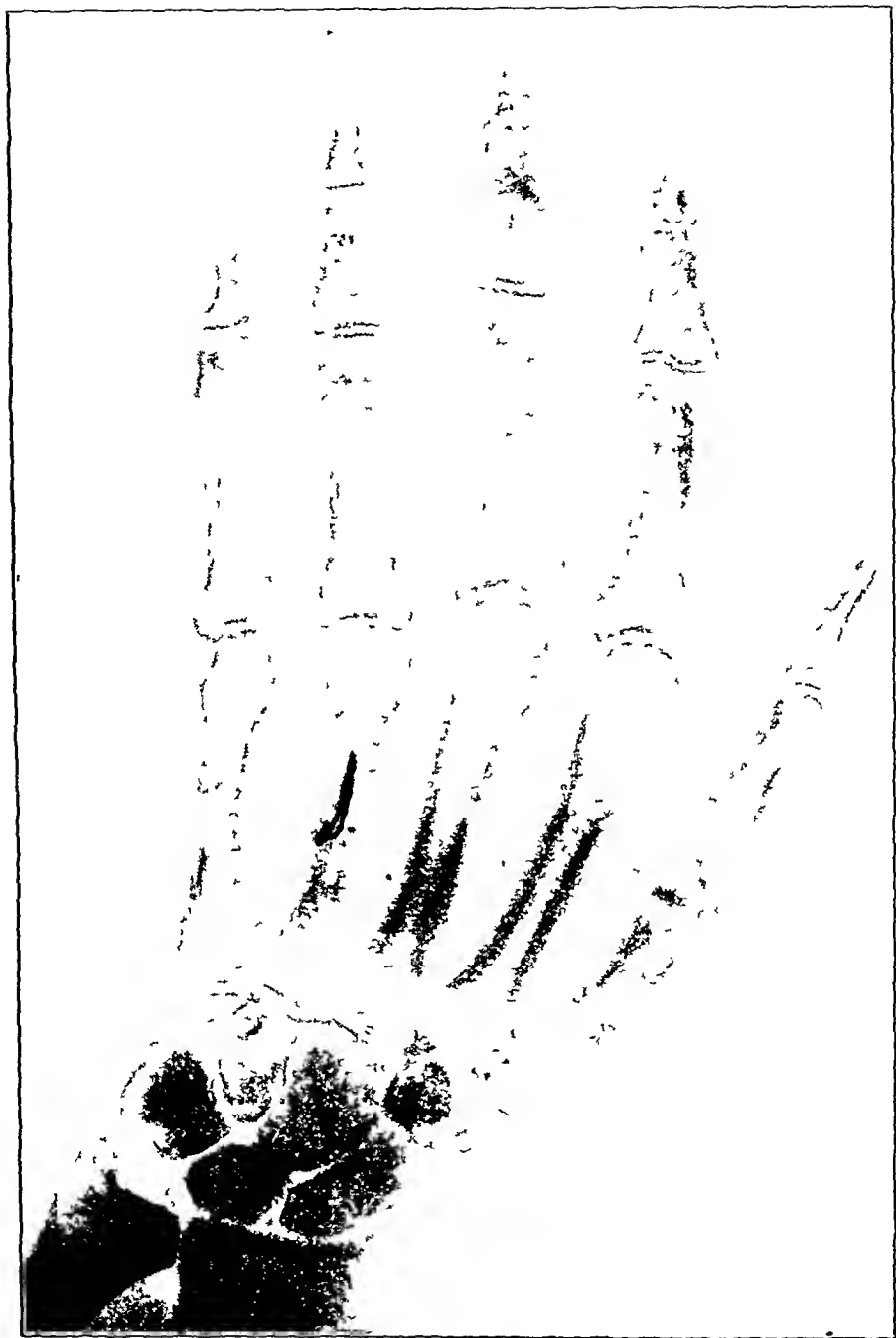
## PLATE XIX



FRACTURE OF THE FOURTH AND FIFTH METACARPALS, EIGHT WEEKS AFTER THE ACCIDENT. IN THE FOURTH METACARPAL THE FRAGMENTS OVERLAP AND IN CONSEQUENCE THE FINGER IS SHORTENED, AND THE LINE OF THE KNUCKLES IRREGULAR.



# PLATE XX



SNIAGRAM OF SAME HAND AS PLATE XIX FOUR WEEKS AFTER OPERATION (W ROSE) THE FOURTH METACARPAL IS NOW STRAIGHT, AND THE ENDS KEPT IN APPPOSITION BY SILVER WIRE, THE UNION WAS FIRM, THOUGH THE CALLUS WAS STILL INVISIBLE BY SNIAGRAPHY. THE LENGTH OF THE FOURTH FINGER IS PRACTICALLY NORMAL





this position, and the deformity, which persists, determines weakness and disability of the thumb. **Treatment**—The fracture is reduced by traction. A poroplastic splint is moulded to the anterior (palmar) aspect of the thumb, reaching above the wrist, it is first fixed to the distal end by strapping, and then bandaged above, so that extension is continuously applied.

Skiagraphy has demonstrated that many 'sprains of the wrist' are in reality due to fracture of a carpal bone, and of these a transverse fracture through the waist of the scaphoid is perhaps the most common. As a rule, rest and subsequent massage are alone required, but occasionally movement is impaired by a displaced fragment, and then its removal is necessary.

### Fractures of the Pelvis

Fractures of the pelvic bones are almost always the result of direct injury, such as blows, gunshot wounds, and railway, carriage or cart accidents. For convenience they may be described under the following headings:

1. **Fractures of the False Pelvis**—A portion of the crista ili may be broken off, or the anterior or posterior spines separated, or merely a fissure in the bone produced.

But little importance attaches to such conditions, as the displacement can never be great, although a portion of the crest may be drawn down by the glutei muscles, or the anterior superior spine displaced by the sartorius, in severer cases, when the bones are crushed and comminuted, the true pelvis is also likely to be affected, and more serious consequences may then arise. Considerable



FIG 173—FRACTURE OF THE PELVIS  
(BRYANT)

pain is always produced by these conditions, especially on any vigorous respiratory movements. Union occurs readily if the patient is kept quiet in bed with the shoulders raised, and the legs supported to relax the muscles. A flannel bandage round the pelvis gives comfort and support.

2. **Fracture of the True Pelvis** is a much more serious accident. The line of fracture usually runs into the obturator foramen, and may detach both the horizontal ramus of the pubes and the ascending ramus of the ischium from the rest of the innominate bone (Fig 173). This is frequently conjoined with a fracture through the sacro-iliac synchondrosis either on the same or opposite side, but more frequently the latter, whilst a double fracture, front and back may also occur at these, the weakest, points. The cause of the posterior fracture is that,

when the pelvic ring has yielded anteriorly from the violence, the continued strain, whether directed from the front or from the sides, must necessarily fall on the part where the ilium is most closely connected with the sacrum, and the bones then give way rather than the unyielding and powerful sacro-iliac ligaments. The **Symptoms** are those of shock and pain in and around the pelvis, especially on movements of the legs or on coughing. There may be local ecchymosis and tenderness over the pubic ramus, and the patient either cannot stand, or feels as if he were falling to pieces on attempting to do so. There is rarely any deformity, although occasionally such an occurrence is noted. Crepitus may be elicited on grasping the iliac bones, and moving them one on the other, but such a method of investigation must be very sparingly indulged in. Complications frequently arise from injury to the internal viscera, especially the bladder, rectum, urethra, or vagina, as indicated by hæmorrhage into or from these organs. An aseptic catheter should be passed as a routine proceeding, and tied in if the urine is blood-stained.

**Treatment**—The patient should be moved with the greatest care, for fear of producing or increasing visceral complications. He is put to bed, and any obviously displaced fragments reduced, if practicable, possibly under an anæsthetic. A broad flannel bandage should be applied, the knees tied together, and a leather or poroplastic splint moulded to the pelvis. Visceral complications must receive attention, as indicated elsewhere. Union may be expected in about six weeks, but the patient should be kept in bed for at least eight, and even then only allowed to get about on crutches, wearing a padded belt.

3 **Fracture of the Acetabulum** is of two types—either the posterior lip is broken off as a result of violence directed against it by the head of the femur, which is dislocated backwards by the same accident, or a fall on the trochanter may cause a simple fissure extending into or across the cavity, or may resolve it into its three constituent elements, or may even drive the head of the bone into the pelvis. In the former case, the limb is in the position of a dorsal dislocation, this can be reduced without difficulty, and possibly with crepitus, but manifests a great tendency to recur. Prolonged extension with a long splint is needed in such cases. In the latter class of injury a mere fissure of the acetabulum produces but few symptoms beyond a little pain and impairment of movement, but if the head of the bone is driven into the pelvic cavity, the symptoms are much more serious, on account of the associated injuries to the viscera and the greater amount of violence employed. The case will resemble one of fracture of the neck of the femur, but there is usually only very slight mobility, and the head of the bone may be felt within the pelvis on rectal examination. An attempt should be made to free the head of the bone, and the case treated as one of fracture of the neck of the femur, but a fatal issue is very likely to follow.

4 **Fracture of the Tuber Ischii** results from falls in the sitting position. The diagnosis is often obscure.

5 **Fracture of the Sacrum** is always due to direct violence of con-

siderable severity, such as kicks, blows, or gunshot wounds. It is not unfrequently comminuted, and, from the associated injury to the lower sacral nerves, may result in loss of power of the bladder and rectum. In a transverse fracture, the lower fragment is usually displaced forwards, and may cause pressure upon the rectum, irregularity in the shape of the bone may be detected from within (*per rectum*) or from without. **Treatment**—The lower fragment should be replaced, if possible, but considerable difficulty may be experienced in keeping it in position. A well-fitting pelvic band, with rest in bed, is probably all that is necessary.

6 **Fractures of the Coccyx** result from falls or blows, although its mobility often protects it from injury. Great pain is felt on walking, or on any movement which increases the intra-abdominal pressure, such as straining, coughing, defæcation, etc., since the coccygeus muscle which is attached to this bone forms part of the pelvic diaphragm. A rectal examination reveals preternatural mobility of the lower fragment, angular deformity, and perhaps crepitus. The **Treatment** consists in keeping the patient at rest until union has occurred, it is impossible to apply any apparatus, and hence the bone may unite at an angle, causing pain, discomfort, and difficulty in parturition. *Excision of the bone* is then required. The patient lies semi-prone with the legs slightly flexed, or in the lithotomy position, and a longitudinal incision is made in the middle line. The apex and lateral margins of the bone are cleared, and the ligamentous tissues uniting it to the sacrum divided by the knife, the bone is now laid hold of by sequestrum forceps, and its remaining attachments severed; due precautions being taken not to encroach on the rectum. Two or three stitches are inserted, and also a drainage-tube for a few hours; the dressing is secured in position by a T-bandage. The bowels should be confined for some days after the operation.

Falls upon the coccyx, unaccompanied by fracture, sometimes give rise to a most severe and intractable type of neuralgia, known as **coccydynia**, which may quite prevent the patient from following his avocations. If all the usual sedatives fail in giving relief, the bone must be excised.

### Fractures of the Upper End of the Femur

1 **Fractures of the Neck of the Femur** may involve any portion of this region, but for clinical purposes are usually divided into those near the head and those affecting the base near the trochanter.

**Fracture of the Cervix Femoris near the Head** (the so called *intra-capsular* variety, Fig. 174) is most frequently met with in persons of advanced age, and especially in females. This is explained by the atrophic changes which take place in the cervix femoris of elderly people. The spaces between the bony cancelli are enlarged and loaded with soft fat, whilst the ensheathing compact tissue is thinned, and the 'calcar femorale' of Merkel (*ic*, the process of thick cortical

substance running from the lesser trochanter to the under part of the head) is atrophied. The neck of the bone is sometimes more horizontal than usual, and the head sinks below its usual position. Under such circumstances, it requires but little violence to produce a fracture, the direction of which varies according to the force applied. As a

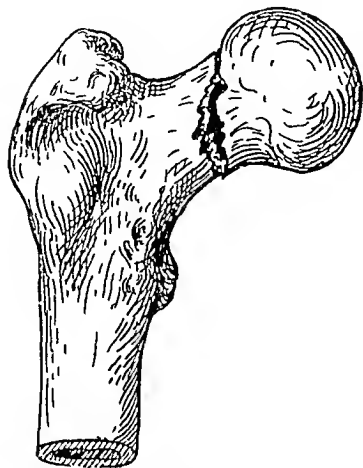


FIG. 174.—FRACTURE OF THE CERVIX FEMORIS NEAR THE HEAD

rule, the accident is due to some slight stumble or fall, such as slipping off the kerb or tripping upstairs, the bone yields in consequence, and the patient falls to the ground. The line of fracture may be transverse or oblique, and is mainly intracapsular. Some of the fibres reflected from the under surface of the capsule to the head of the bone may remain untorn at first, but later on they may give way from inflammatory softening, injudicious manipulation, or attempts to use the limb. The fracture is not usually impacted, if, however, this condition should occur, the upper end of the neck is driven into the loose cancellous tissue of the head. The *displacement* is necessarily limited entirely to the lower fragment, which is drawn upwards by the glutei, recti, and ham-

string muscles, and rotated outwards and somewhat backwards, so that the fractured surface looks almost directly forwards.

The *Method of Repair* in these cases depends to a large extent upon the general condition of the individual. If of a healthy temperament, and without any chronic pulmonary affection, so that he can be kept in the recumbent posture for six or eight weeks, bony union may certainly occur, in spite of the fact that at first synovial fluid finds its way between the fractured surfaces. The main process of repair takes place from the lower end, but little callus being formed from the head of the bone, the vascular supply being only just sufficient to maintain its vitality. If, however, the patient is feeble and weakly, and especially if the subject of chronic bronchitis and emphysema, the prognosis is by no means good, since hypostatic pneumonia and extensive bedsores may carry him off during the short stay in bed which is always necessary in order to relieve the more urgent symptoms of pain. Bony union is never, under these circumstances, to be expected, and a loose fibrous union, or even a false joint, is the best that can be looked for, the patient henceforth walking with the assistance of a stick or crutch. Not unfrequently the neck is absorbed and the shaft slips up on the dorsum ili, the weight of the body being carried by the outer limb of the Y-ligament of Bigelow and the obturator internus tendon. The prognosis is, of course, much improved by the presence of impaction, and the fear of breaking this down must ever be in the mind of the examining surgeon, whilst the integrity

of bridges of periosteum and reflected fibres from the capsule also improves the outlook

Radiographic examination has shown that a similar type of fracture of the neck occurs in *children and young people*. It is not unfrequently incomplete, and associated with bending of the neck. The patient often recovers mobility of the limb, and can walk about after resting in bed for a few days, but the deformity persists, and, in fact, increases from further yielding of the softened bone, so that in time a typical *coxa vara* results. A similar deformity follows a partial separation of the upper epiphysis. A mistaken diagnosis of tuberculous coxitis may be made, unless one clearly appreciates the rapid appearance of the symptoms after an injury, and the facts that the trochanter is raised, the limb shortened, and the movements limited only in particular directions or not at all. If there is complete separation, treatment is best carried out by fixation with plaster of Paris in an abducted position, and by prolonged freedom from the body-weight, so as to allow the callus to harden, as by the application of a Thomas's hip-splint

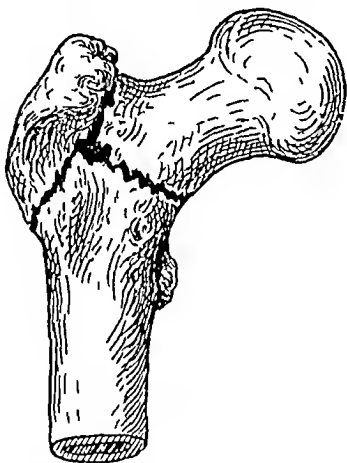


FIG 175 —FRACTURE OF CERVIX FEMORIS NEAR THE BASE (SEMI-DIAGRAMMATIC FROM THE FRONT)

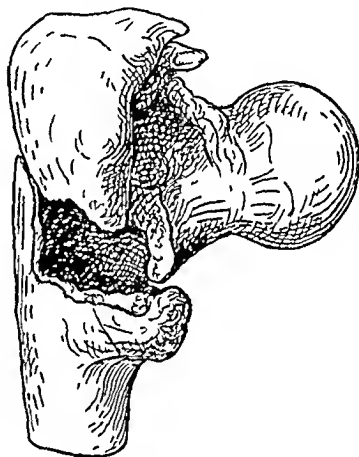


FIG 176 —FRACTURE OF NECK OF FEMUR NEAR THE BASE, SEEN FROM BEHIND (COLLEGE OF SURGEONS MUSEUM)

The head and neck are depressed, and the trochanter major drawn slightly upwards

**Fracture of the Cervix Femoris near the Trochanter** (the so called *extracapsular fracture*) always involves the hip-joint, since the capsule extends to the shaft of the bone along the anterior intertrochanteric line, and leaves no portion of the neck uncovered in this situation. The line of fracture is placed in front, either along the attachment of the capsule (Fig 175) or well within it, and is really only extracapsular behind, sometimes, moreover, the shaft itself is considerably encroached on. The great trochanter is often involved in the fracture, being splintered or detached, and the lesser trochanter may be split off with a portion of the shaft, so that the bone is broken into at least three different fragments (Fig 176)

**Mechanism** —This fracture is usually the result of direct violence

acting transversely upon the trochanter major, as from a heavy fall upon the hip. The posterior part of the neck, being weaker than the anterior, first gives way, being more or less crushed and comminuted, the whole neck then yields, and the severed head and neck are forcibly impacted into the junction of the trochanter and shaft. The majority of these cases are thus primarily impacted, continuation of the violence producing disimpaction, coupled either with detachment of one or both trochanters, or with comminution of the great trochanter. Disimpaction may also follow at a later date from the rarefaction associated with the early stages of repair or from injudicious manipulation.

The *displacement* is much the same as in the former variety, the upper fragment remains in the acetabulum, whilst the lower is drawn up and everted, only to a greater extent. Shortening may at first be slight, but is likely to increase at the end of a few days, as a result of disimpaction of the fragments, or from the yielding of the reflected fibres of the capsule, or from the tonic action of the muscles.

*Union* of the fragments is much more certain in this variety than in the intracapsular, but it is often accompanied by a considerable development of callus, which may subsequently impair the movements of the limb, whilst secondary bending and late increase of the shortening may occur if the patient walks too soon.

The **Signs and Symptoms** of these two fractures may well be considered together, the points of similarity and contrast being in this way more effectually emphasized.

(a) The signs of *local trauma*, viz, pain, bruising, and swelling, may be present in both, but whilst slight in the intracapsular variety, they are very marked in the extracapsular. It must not be overlooked, however, that even in the former the patient may fall on the affected hip after the fracture has occurred, and thus cause a considerable amount of bruising.

(b) *Crepitus* is evident in the unimpacted forms of each, but it is unnecessary and, indeed, extremely unwise to elicit it by forcible manipulation, especially in the intracapsular variety.

(c) *Loss of power* is perhaps more marked in the extracapsular form than in the intracapsular. Cases of the latter in which the patient was able to walk into hospital some days after the accident are not unknown, and are probably due to impaction.

(d) *Eversion* is a most characteristic feature in both varieties, the limb lying absolutely helpless on its outer side. This displacement is accredited to the natural weight of the limb, to the greater fragility of the back of the cervix, causing it to be more comminuted than the anterior surface, and, lastly, to the greater power of the external rotator muscles. *Inversion* has been met with in a few rare cases, but is probably due to the violence in the particular instance being directed from behind forwards, and to impaction of the fragments.

(e) *Shortening* is slight in the early stage of intracapsular, and much greater in the extracapsular, fractures. In the latter case the shortening usually attains its maximum—viz,  $1\frac{1}{2}$  to  $2\frac{1}{2}$ , or even 3 inches—at once, but such is not always the case in the former. It is indicated

by displacement of the trochanter upwards, due allowance being made for the position of the limb as regards abduction or adduction

(f) The *position of the great trochanter* is of the greatest importance. It is raised above its ordinary level and everted, it is approximated to the middle line of the body and to the anterior superior iliac spine, and rotates in the arc of a smaller circle than usual, the radius being the thickness of the trochanter alone, instead of including also the length of the neck. The demonstration of this position is most important, and, amongst others, the following tests are employed

*Nélaton's line* (Fig 177) is one drawn from the anterior superior spine to the most prominent point of the tuber ischi (AB). The centre of this (D) corresponds to the top of the great trochanter, if the limb is placed in the axis of the body, but if either abduction or

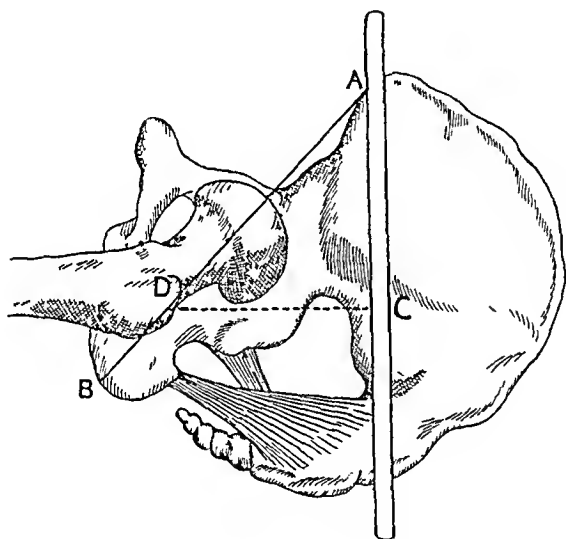


FIG 177 —NELATON'S LINE AND BRYANT'S MEASUREMENT FOR ASCERTAINING POSITION OF GREAT TROCHANTER

adduction is present, the top is situated slightly above or below the line. Definite elevation of the bone above the line indicates shortening of the limb due to dislocation backwards, fracture of the neck, or absorption of the neck from disease

*Bryant's Test-Line* (Fig 177) —In this the patient lies flat on a horizontal couch, and a vertical line (AC) is drawn from the anterior superior spine, a thin wooden rod held against the side answers this purpose admirably. The perpendicular distance of the top of the great trochanter from the line (CD) is compared with a similar measurement on the opposite side, definite shortening may thus be discovered. In the normal adult this measurement is usually about  $2\frac{1}{2}$  inches

*Morris's bitrochanteric* test indicates the amount of inward displacement. It is conducted by measuring the distance between the outer



surfaces of the trochanters and the middle line of the body by means of a rod graduated from the centre, along which two pointers work outwards. Shortening in this direction will also be observed in most dislocations of the hip-joint.

One other change in the great trochanter may be noted in the extra capsular form of fracture, which can be utilized as a useful diagnostic feature between it and the intracapsular variety, viz., the great amount of *thickening* of the process which is always produced, owing to the excessive development of callus. In the intracapsular variety it is rarely fissured or injured, and therefore no thickening occurs.

(g) Lastly, *relaxation of the fascia* between the crest of the ilium and the great trochanter (that is, of the upper part of the ilio-tibial band) is given as a characteristic feature of these fractures.

**Diagnosis**—Simple *unimpacted* fractures are readily detected, and there can be but little difficulty in distinguishing the two forms, either from one another or from other injuries. The fact that an *impacted* fracture has occurred can also be easily made out as a rule, the pain, eversion, and shortening sufficing to indicate its existence, but it is very often difficult to say which of the two forms of fracture is present, especially if the surgeon is not called till late in the case. The character of the accident and the age of the patient must be taken into account, whilst the existence of *fissuring* or *thickening* of the trochanter, or an excessive amount of shortening, would suggest that the lesion is located near the trochanter. A *severe-contusion* of the hip, which may be associated with marked eversion, is known from a fracture by the absence of shortening and crepitus, there is no displacement of the trochanter, which rotates in a normal manner. The shortening which sometimes follows, owing to subsequent atrophy of the neck, may, however, complicate matters. In a *dislocation* the head of the bone can be felt in an abnormal position, and hence no difficulty should be experienced in its recognition. In *chronic osteo-arthritis* of the hip with antecedent shortening and marked bony crepitus, there may be no history of accident, and no acute eversion, pain, or loss of power, possibly the existence of similar disease in other joints may assist the surgeon, whilst osteo-arthritis of the hip usually results in prominence of the trochanter, and not in flattening, as occurs after fracture. Moreover, the fascia above the trochanter is never relaxed in osteo-arthritis, always in fractures. It must not be forgotten that, after an intracapsular fracture, the patient may fall, not on the injured side, but on the sound thigh, and cases have been known where the surgeon's attention was directed to the wrong limb owing to the amount of bruising there manifested. The X rays may be advisably employed to assist in making a diagnosis, but it is wise to pass them through a small diaphragm so as to get concentration of action, and a more defined shadow of the bones.

The **Treatment** of intracapsular fractures must depend in great measure, as already stated, upon the individual. If old, weakly, and with a tendency to chronic bronchitis, long confinement to bed would have a most deleterious, if not fatal, effect. In such cases the limb

is put at rest for a few days between sandbags, and cooling lotions applied. A Thomas's splint should be fitted as early as possible, and the patient encouraged to get about on crutches.

In a healthy individual with good physique, where bony union may be expected, the patient is kept at rest in bed for six or eight weeks, by means of Liston's splint (Fig 178). This needs careful adjustment, but gives satisfactory results when properly applied. It should reach from the axilla to about 6 inches below the ankle, and is fixed to the leg and body either by bandages, or, better, by two broad sheets, which first firmly envelop the splint, and are then passed round the body, and finally secured by pins to the portion surrounding the splint. Before applying it, carefully-padded poroplastic foot-pieces are placed on either side of the ankle, so as to protect it from pressure, and a handkerchief or bandage passed round the foot and through the prongs at the end of the splint fixes it in position. A well-padded

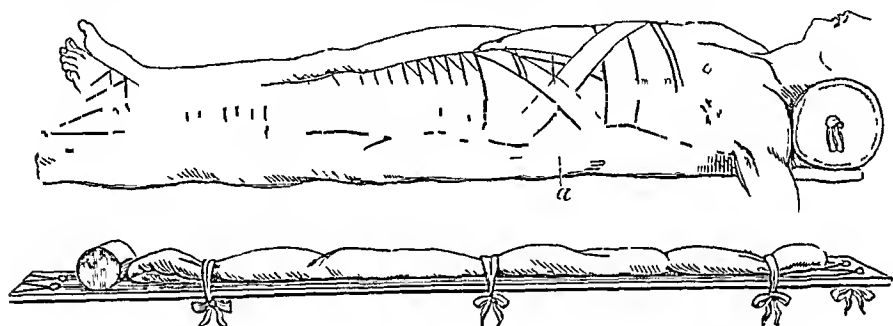


FIG 178—LISTON'S SPLINT PADDED AND APPLIED  
a, Perineal band

perineal band is next applied, taking its purchase from the tuber ischii, and with its free ends passed through the two holes at the upper extremity of the splint, by tightening and tying these two together, the upper end of the splint is steadied. Extension of the limb is obtained by an elastic accumulator, or by weight and pulley. Lateral movement or rotation is prevented by slipping the lower end of the splint into a slot between two rectangular plates of metal screwed to a substantial wooden base, which rests on the bed. The handkerchief and perineal band will need occasional tightening to maintain the required position, and the latter must be renewed from time to time for purposes of cleanliness, and the parts well powdered with boric acid. At the end of six weeks or so the pelvis should be encased in poroplastic material or plaster of Paris and the patient allowed to get about on crutches, or a Thomas's splint is applied.

No attempt should be made to disimpact fractures in old people, rest and quiet are maintained by applying a long splint without extension, and bony union usually follows.

Extension by weight and pulley is required in so many different conditions that a description of its method of application is necessary.

Two pieces of broad adhesive plaster are prepared as in Fig 179, they should reach from well above the knee to the malleoli. The upper ends are notched obliquely to make them fit better to the limb, whilst the lower are folded on themselves so as to cover in the adhesive surface. A stirrup is then prepared as in Fig 180, adhesive plaster is fixed to a wooden spreader, rather broader than the ankle, with a hole in its centre for the passage of a cord. The long strips are applied on either side of the limb, and secured to it by a woollen or boracic bandage, which should not extend much below the knee. The stirrup is then attached to the strips by safety-pins ( $A_1$  to  $A$ ), the cord is passed over a pulley fixed to the end of the bed, and to it is attached a suitable weight. The lower end of the bed is raised by

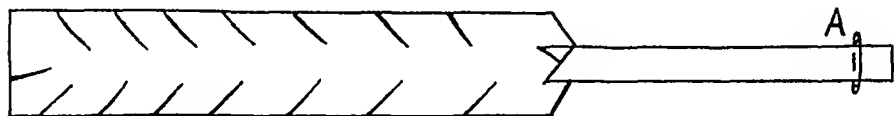


FIG 179 —METHOD OF CUTTING AND FOLDING THE STRAPPING IN APPLYING EXTENSION

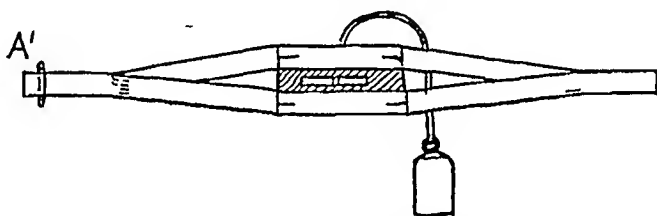


FIG 180 —METHOD OF ARRANGING STRAPPING ON STIRRUP OR 'SPREADER'

The end  $A_1$  is attached by a safety-pin to  $A$ , the end of the upper piece of strapping in Fig 179, and a similar attachment is made on the other side of the limb to the other piece of strapping

placing the legs on blocks, so that the weight of the body may act as a counter-extending force. Various splints may be combined with this appliance without impairing its value.

In America *Buck's* method of *extension* is much employed and gives great satisfaction. It may well be utilized in fractures of the cervix. The above-described extension is employed, but in addition a third strip of plaster, 1 yard long and 2 inches wide, is fixed to the back of the calf, brought down below the sole of the foot, and secured by a roller bandage. A *Volkmann's* sliding rest (Fig 181) is then placed under the limb, and secured to it by the loose end of strapping and a bandage.

**Treatment of Fracture near the Trochanter** —The long splint with extension, or *Buck's* extension alone, will sometimes suffice for this condition, good bony union usually occurring, though with some shortening. In other cases it may be advisable to make extension from the knee, and to keep the limb slightly flexed, as on a double inclined plane.

Probably this type of treatment is best carried out by the use of *Hodgen's splint* (Fig 182). For our description of it we are chiefly indebted to Mr Golding Bird. It consists of a rigid iron frame in the form of the letter U, the outer limb reaching from the anterior superior spine to 3 inches below the instep, and the inner from the adductor longus tendon to the same spot, where the two limbs unite in a cross-bar 3 inches in width. The sides taper with the limb, and should be  $\frac{3}{4}$  inch further apart than the diameter of the limb at any point. At the upper end the bars are united by an arch of the same material, which should correspond to Poupert's ligament, one or two similar arches are placed at equal points lower down. The splint is slightly bent at the knee.

Before applying the splint, an ordinary extension apparatus is attached to the limb. Strips of house-flannel, about 7 inches wide,

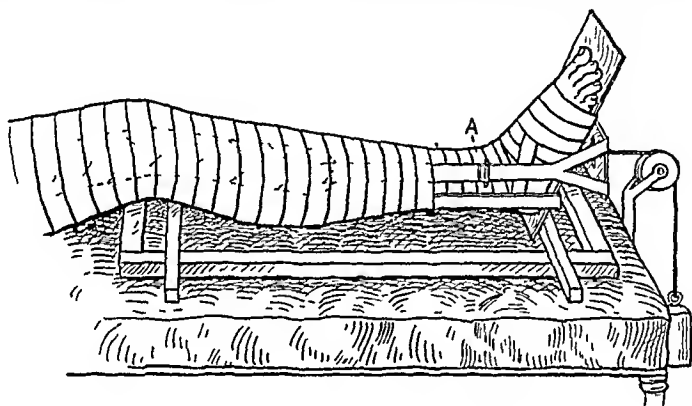


FIG 181—VOLKMANN'S SLIDING REST FOR FRACTURES OF THE FEMUR  
A points to the junction of the upper and lower pieces of strapping as in  
Figs 179 and 180

are then cut and arranged beneath the limb at right angles to its direction, each one overlapping the next, the length of the strips should be rather more than the circumference of the limb at the spot to which each is to be applied. The splint is then placed in position, the strips of flannel are raised in succession, and, being lapped over the bar, are pinned or stitched there, so that the limb lies in a flannel trough, from which only the upper surface projects. The cord of the extension appliance is then securely tied to the lower end of the splint. Two hooks are soldered to each side of the frame, and to them are attached cords, which are brought together over the limb, another stout cord is tied to these and passes over a pulley attached to a vertical post at the end of the bed, it is weighted to a sufficient extent. The limb when the weight is applied should lie free of the bed, even to its extreme upper limit. It is advisable to encircle the thigh in Gooch splinting, a narrow piece in front between the bars and a broader piece behind. These are well padded and secured by bandages which extend over the whole length of the

apparatus, finally, starch is rubbed in so as to fix it more firmly. When correctly applied, the splint itself is pulled on by the extending force (the weight), and this is transmitted to the limb through the stirrup end, which should be taut 'like a harp-string', laxity of this end indicates slipping of the splint, and necessitates its readjustment.

When impaction of an extracapsular fracture has occurred in young and active individuals, it is quite justifiable to give an anæsthetic, and forcibly break it down, so as to prevent subsequent shortening.

2 **Fracture of the Great Trochanter** is very rare, and always due to direct violence, in the young it occurs as an epiphyseal lesion. The trochanter, or a portion of it, is entirely separated from the rest of the bone without any loss of the continuity of the shaft. Independent movement of the fragment with crepitus is usually obtainable, and

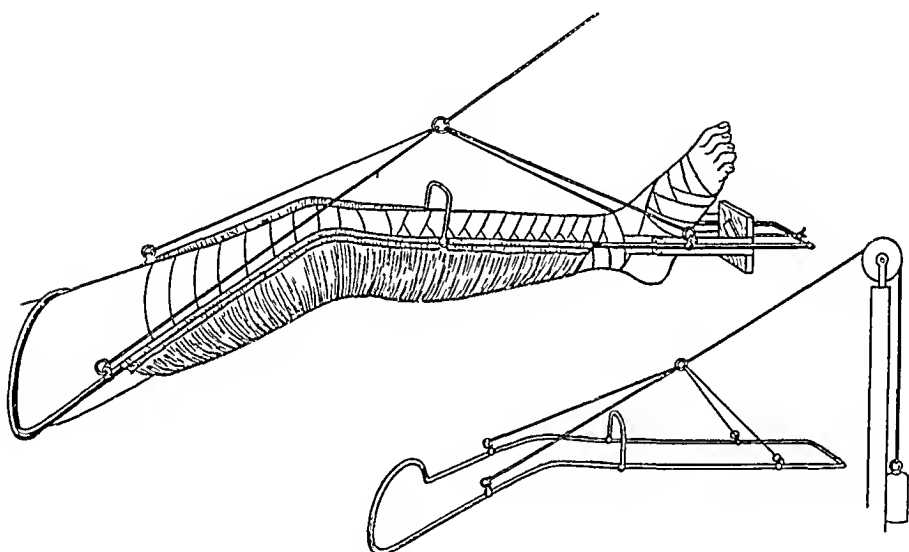


FIG 182 —HODGEN'S SPLINT AND ITS METHOD OF APPLICATION

if the displacement is at all marked, an operation to fix it by means of a plated screw or ivory peg should be undertaken.

3 **Fracture through the Great Trochanter** (the *per-trochanteric* fracture of Kocher) closely resembles the extracapsular fracture, the lesion running from the inner and under part of the neck obliquely upwards and forwards through the base of the trochanter. The lower fragment, including the lesser trochanter, is drawn upwards and backwards towards the sciatic notch, and forms a projecting mass behind, somewhat simulating a dislocation, the tip of the trochanter can, however, be felt separately, not moving with the shaft. Such cases may be treated by extension with the long splint, or perhaps better by Hodgen's apparatus.

4 **Separation of the Upper Epiphysis of the Femur**—The upper cartilaginous end of the femur in infants includes not only the head,

but also both trochanters, and there is no case on record of complete detachment of this portion. Ossific centres early appear for each of these three projections, and by the rapid growth upwards of the shaft they are separated from each other by the fourth year, the neck thus being really constituted as an outgrowth of the shaft. The epiphysis of the head has been completely detached in a considerable number of cases, but the accident is not so common as in the humerus,

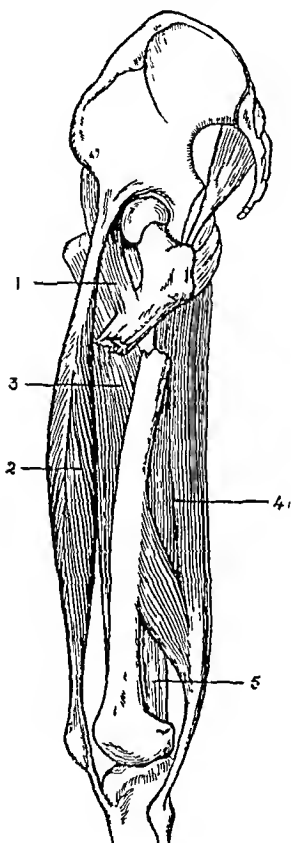


FIG 183—FRACTURE OF UPPER THIRD OF FEMUR, SHOWING DISPLACEMENT OF BONE (AFTER GRAY'S 'ANATOMY')

1, Ilio-psoas tendon, 2, rectus, 3, adductor, 4, biceps, 5, inner hamstring tendons

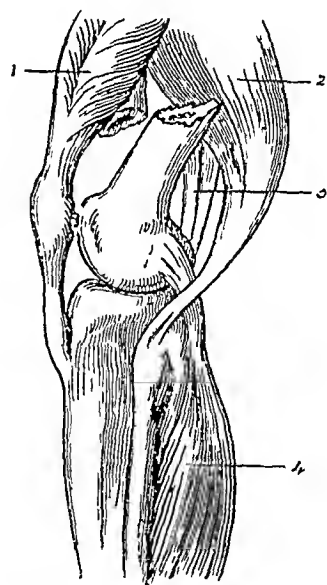


FIG 184—FRACTURE OF LOWER THIRD OF FEMUR, SHOWING DISPLACEMENT OF LOWER FRAGMENT BACKWARDS (AFTER GRAY'S 'ANATOMY')

1, Rectus, 2, biceps, 3, semimembranosus and semitendinosus, 4, gastrocnemius

owing to the protection given by the depth of the acetabulum. The phenomena closely simulate those of an intracapsular fracture, but are less obvious (p 537). Impairment of growth may follow, and possibly the shape of the head and neck may be so altered subsequently as to simulate the condition known as coxa vara. Treatment of the lesion is by prolonged fixation of the limb in an abducted position.

**Fractures of the Shaft of the Femur** are extremely common

accidents, in spite of the apparent strength of the bone. Any part may be involved, particularly the centre, whilst they occur at the lower end more frequently than at the upper. In the latter situation they are usually due to indirect violence, whilst at the lower end they generally result from direct injury, either form of violence may lead to a fracture about the middle of the bone.

In almost every case *displacement* occurs, the direction and amount of which depends not only on the line of fracture, but also on the situation. In the *upper third* (Fig 183), the small upper fragment is usually tilted forwards by the *ilio psoas*, and abducted and everted by the *gluteus minimus* and external rotators, whilst the lower fragment is drawn upwards and to the inner side of the upper by the hamstrings and adductor muscles, marked eversion also resulting, partly from the weight of the foot, and partly from the action of the adductors, but such a complicated displacement is not always present.

In the *middle third*, if due to indirect violence, the line of fracture usually slants from above downwards and backwards, causing a simple overriding of the fragments or an angular deformity. The lower fragment is drawn upwards and inwards, either in front of or behind the upper fragment, and is usually everted. The upper fragment is sometimes tilted forwards. If due to direct violence, the fracture is more or less transverse, often comminuted, and any form of displacement may then occur.

In the *lower third* the fractures often arise from direct force, and are transverse, the lower fragment may then be tilted backwards by the *gastrocnemii* muscles, and compress or rupture the popliteal vessels, perhaps causing gangrene (Fig 184). Oblique fractures from indirect violence, sloping from above downwards and forwards, are also met with, the upper fragment is driven into the substance of the quadriceps muscle and may become fixed in it, projecting immediately beneath the skin, whilst the lower fragment is drawn up behind. If such a case is left unreduced, non-union is likely to ensue, the knee-joint is generally penetrated by the lower end of the upper fragment.

**Treatment**—In the *upper third*, where the upper fragment is often too short to be controlled by any splint, reduction of the deformity is accomplished by flexing the thigh, and making extension from the knee, the lower fragment being thus brought into the same axis as the upper. Manipulation will usually correct any lateral displacement. The limb must be confined in this position by some form of inclined plane, such as a Macintyre's splint, with a long thigh-piece, and with small straight wooden splints or a piece of Gooch's splinting fixed, if necessary, to the front and outer sides of the limb, over the seat of fracture. The splint is slung at the knee, the foot-piece being fixed to blocks of wood, a little lower than the level of the knee. If these precautions are not taken, an ununited fracture, with the upper fragment in front of the lower, is likely to occur. Hodgen's apparatus also answers admirably in these cases.

In the *middle third* of the thigh, where the upper fragment can be controlled by splints, shortening is prevented by extension (p 542), the thigh being surrounded by pieces of Gooch's splinting, which grasp the muscles and keep the parts at rest. The limb is then placed between sandbags, or secured on a Liston's-splint. A half-box splint (*i.e.*, a long splint with a back-piece) may be successfully employed in many of these cases, the limb being firmly bandaged to the appliance. Where the fracture is oblique, with a good deal of tendency to overlap, Hodgen's apparatus may be utilized.

In the *lower third*, if there is any tendency to displacement of the lower fragment backwards, a Macintyre's splint, with a long thigh-piece and the knee well flexed, may sometimes be employed, together with a short anterior thigh piece of Gooch's splinting, but in the oblique type, if the upper fragment has penetrated the quadriceps, operation alone holds out any prospect of bringing the parts into apposition, the muscular fibres being divided sufficiently to allow the projecting end of the bone to be replaced, and if necessary wired or pegged. In other cases the ordinary long splint or Hodgen's will be required.

In children, Bryant's plan of treatment is excellent, it consists in slinging the limb from a crossbar at right angles to the body, with or without a back-splint, reaching from the heel to the nates, and short lateral splints, thus obtaining extension by utilizing the weight of the body, whilst the bandages, etc., are kept from being soiled. If a long splint is used for children, a double one (*e.g.*, Hamilton's splint) with a crossbar below is the best. Plaster of Paris or starch bandages may be early applied in adults, but only in the later stages in young children, as they are difficult to keep clean.

### Fractures of the Lower End of the Femur

1 **Transverse Supracondylar Fracture** is practically identical with that involving the lower third of the femur, the lower fragment is rotated backwards by the action of the gastrocnemii, thus endangering the integrity of the popliteal vessels, and predisposing to non-union, if the deformity is overlooked.

2 **T- or Y-shaped Fracture of the Condyles**—In this a transverse fracture is complicated by a fissure, which runs into the joint, separating the two condyles. The symptoms are much the same as the above, but the joint is distended with blood, the bone may feel broader than usual, and crepitus may be detected. The **Treatment** is the same as for transverse fracture.

3 **Separation of either Condyle** always results from direct violence, the line of fracture being oblique. There is no shortening, but the leg may be deflected towards the side injured, and the joint is distended with blood. It may move separately from the shaft, and give rise to crepitus. **Treatment**—Reposition is easily effected when the limb is slightly flexed, and it is best put up in this position.

Occasionally a small portion of the condyle may be detached and



lie loose in the knee-joint, when the immediate symptoms due to the injury have subsided, the signs of a foreign body in the joint may become evident

4 **Separation of the Lower Epiphysis of the Femur** is not a very rare accident, and closely simulates a transverse fracture. The epiphysis is generally displaced forwards by the traction of the quadriceps on the tibia, and the vessels are then compressed by the lower end of the diaphysis, and this may lead to gangrene. Suppuration occurs in a fair proportion of the cases. **Treatment**—Reduction is effected by an assistant making traction on the tibia in the line of the limb so as to stretch the quadriceps, then the thigh is gradually flexed by the surgeon, standing above and with both hands clasped beneath it. The epiphysis is by this means restored to its normal position, and the limb is kept flexed by a bandage at about an angle of  $60^\circ$ , and laid on its outer side with an icebag applied. Passive movement is carefully commenced in a fortnight.

5 **Longitudinal and Spiral Fissures** are met with in the femur, running down to the knee-joint, but causing no characteristic symptoms beyond pain and hæmarthrosis. Early passive movement is necessary to prevent impairment of function.

### Fractures of the Patella

(The patella is broken either by muscular force or by direct violence, and the conditions produced are so different that a separate description is necessary)

1 **Fractures by direct violence** may traverse the bone in any direction, but are most often vertical or star-shaped, and frequently comminuted. They are usually mere fissures without displacement, owing to the aponeurosis or capsule of the bone remaining intact. There is a good deal of subcutaneous bruising, and perhaps some effusion into the joint, whilst on careful palpation the fissure may be felt, and crepitus occasionally detected. **Treatment** consists in keeping the limb at rest on a back-splint, and perhaps applying evaporating lotions. Passive movements must be commenced early where there has been much hæmorrhage into the joint. Operative measures are rarely required.

2 **Fractures due to muscular force** are always transverse, usually complete, and since they involve the fibrous aponeurosis, considerable displacement occurs.

**Mechanism**—When the knee is semi-flexed, the patella is poised upon the front of the condyles of the femur, resting upon the middle of its articular surface, in this position any sudden and violent contraction of the quadriceps, as in attempting to recover one's equilibrium after having slipped, takes the bone at a disadvantage, and may succeed in snapping it. Possibly in some people there is a predisposing weakness, as cases are not rare in which the other bone yields subsequently, although perfect functional repair has been obtained in that first broken. The fragments may be almost equal in size.

(Fig 185), but the lower is often the smaller, either of them may be again divided vertically, or comminuted. The **Signs** of this fracture consist of loss of power in the limb, pain, distension of the joint with blood, and separation of the fragments, which can be readily felt and sometimes seen (Figs 185 and 186). This displacement is due to unopposed muscular action, and is increased when the lesion involves the lateral expansions of the vasti muscles, as is not uncommon. Union by bone is rarely obtained apart from operation, a fact explained partly by the separation of the fragments, and partly by the carrying in of loose tags of the fibrous aponeurosis or capsule, which yields at a different level to the bone. Fibrous union is the usual result, and when this is short and strong, it may be quite satisfactory, but more commonly

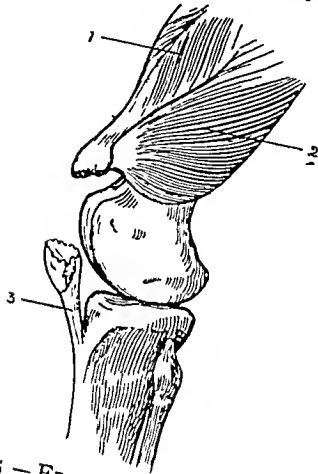


FIG 185 — FRACTURE OF PATELLA WITH SEPARATION OF FRAGMENTS (AFTER GRAY'S ANATOMY)  
1, Rectus, 2, vastus externus, 3, ligamentum patellæ

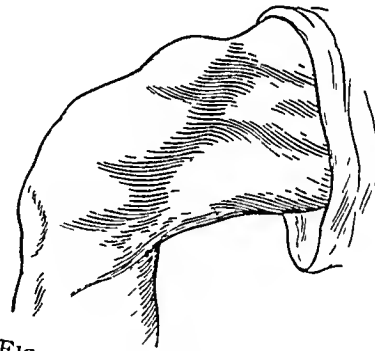


FIG 186 — APPEARANCE OF KNEE AFTER FRACTURE OF PATELLA

the bond of union yields when the limb is used, so that the two fragments are once again separated, merely a bridge of fibrous tissue intervening, the joint being often very weak, and the power of active extension of the leg lost. The **Treatment** of these cases may be grouped under three headings, viz, by retentive apparatus, by subcutaneous operation, or by the open method.

**I. Simple retentive apparatus** may be employed in cases where the fragments are not widely separated, and can be readily brought into contact and maintained in apposition. Some surgeons depend mainly upon plaster of Paris to effect this. If there is but little effusion, the limb is extended, swathed in cotton-wool and a flannel bandage, and over this the plaster casing is applied. As the apparatus becomes loose from muscular atrophy,

it will need readjustment. The patient is kept in bed for three or four weeks, but the plaster is retained for as many months, and after that a suitable knee support (Fig 187) is kept on for nearly twelve months. Where there is much effusion after the accident, the limb is placed on a back-splint and kept cool by ice or evaporating lotion, until the fluid has been absorbed, or the joint may be aspirated in order to hasten matters. The plaster is then applied, and the same routine followed. The chief objection to this plan is the enclosure of the limb in the plaster case, so that the muscles and joint cannot easily be got at for purposes of massage.

Another plan consists in applying a large piece of moleskin plaster over the front and sides of the extensor surface of the thigh, reaching half-way up to the groin, and terminating below in two lateral elongated ends or tags, to which elastic traction is applied. The limb is placed on a back-splint, with a foot-piece, beneath which the elastic accumulator is firmly tied. Removal of the effusion in the joint may be hastened by the use of the aspirator. At the end of about six weeks the patient is allowed to get about in a plaster of Paris casing, and then, about three months after the accident, a special knee-splint is substituted (Fig 187), which allows of only a small amount of mobility at first, but, by filing away a stop, this can be gradually increased, until a full range of movement is permitted. It is probable that only fibrous union is obtained by this method of treatment.

2 To insure more accurate apposition and a firmer union, and yet to avoid the risks necessarily associated with laying the joint open, various *subcutaneous operations* have been adopted. Of these the most satisfactory is that recommended by Mr A. E. Barker, who ties the fragments together by silver wire (Fig 188). An opening is made with a tenotomy knife into the joint just below the lower segment, through which any effused blood or synovia can be squeezed, and along which a curved hernia needle is passed, traversing the articulation from below upwards, and emerging through the skin above the upper fragment. A piece of sterilized silver wire is then carried back under the bone. The needle is again inserted at the same spot below, and carried in front of the bone under the skin, emerging at the same point above. The upper end of the wire is threaded through it, and by this means brought out at the lower opening. The bone is thus encircled, and by tightening and twisting the wire the fragments are brought into apposition. The ends are cut off and pushed back under the skin. The punctures are treated antiseptically, and the limb placed on a back-splint for a week or so, when passive movement is commenced, the patient being allowed to walk about at the end of the second week, and discarding all apparatus at the end of five weeks. Necessarily, a certain element of risk is admitted in any subcutaneous operation, and, in our opinion, if it be justifiable to incur such, it is best to proceed by—

3 The *open plan of treatment*, advocated and perfected by Lord Lister, which consists in freely exposing the interior of the articulation, clear-

ing the joint of all blood-clot, removing tags of fascia or aponeurosis which may curl in over one of the broken surfaces, and wiring the fragments securely together

No surgeon should attempt this operation unless well assisted and thoroughly *au fait* with the details of antiseptic work. At King's College Hospital this practice is now almost exclusively followed, and the results have been most satisfactory, no instance of serious mischief

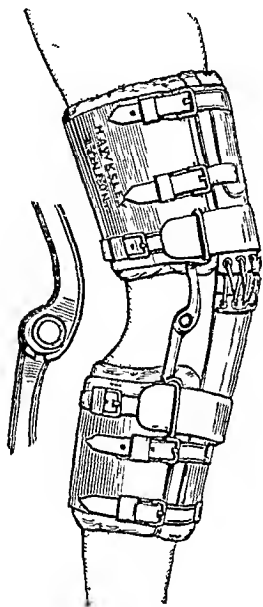


FIG 187 —FRACTURED PATELLA \*

This splint is intended for use after fibrous union of the upper and lower fragments. The steel joints at the sides are so made that the degree of flexion can be gradually increased. In case of a slip the knee cannot bend more than is allowed by this *adjustable stop*, and thus overstretching or rupture of the newly-formed bond of union is prevented. To assist extension of the limb, a strong elastic band joins the upper and lower part of the splint anteriorly, this also is adjustable, and greatly assists the weakened quadriceps in walking.

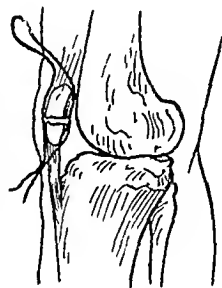


FIG 188 —BARKER'S METHOD OF SUBCUTANEOUS SUTURE AFTER FRACTURE OF PATELLA



FIG 189 — POSITION OF SILVER WIRE IN OPEN OPERATION FOR FRACTURED PATELLA

from the operation having arisen for many years. A horseshoe-shaped flap is usually dissected up, exposing the bone. All blood-clot is removed, and the fractured surfaces cleared of all clot and fibrous shreds, which are very often adherent. Tracks for the wire sutures are now made by a bradawl, extending from the upper or lower end

\* For the loan of this block we are indebted to Mr. T. Hawksley, 357, Oxford Street, W.

through the centre of the bone, so as to emerge on the fractured surface just in front of the articular cartilage (Fig 189), should the awl emerge at different levels on the faces of the fragments, cartilage or bone must be chipped away to make a channel in which the wire may lie, so that the two fragments are exactly level, with no inequality of the articular cartilage. A sterilized silver wire of suitable thickness is then passed, the bones are brought into apposition, and the wire twisted into a knot or loop, which is hammered or pressed down into the tendinous or periosteal tissue over the upper fragment, so as to keep it from projecting under the skin and causing irritation. A second wire is sometimes needed in order to prevent rotation of the fragments. The wound is closed, and the limb kept on a Gooch's splint. In healthy adults passive movement may commence in ten days, and by the end of a fortnight the patient is allowed to walk in the simpler cases, but in complicated fractures and in elderly people it is wiser to keep the limb immobilized for a longer period.

It is perhaps advisable not to undertake this operation immediately after the accident. The limb should be kept at rest on a back-splint and an icebag applied for a week or ten days, so as to allow the joint to recover from the effects of the injury it has sustained, there is then much less risk of septic complications.

The chief advantage of operative treatment is not so much that it alone can ensure bony union, but that the time expended is so much shortened. When a patient can afford to spend twelve months in remedying the accident, and can pay for suitable massage and an expensive splint, firm fibrous union can usually be obtained, and this may be just as satisfactory as if bony union had occurred.

In old cases, where the fibrous union has stretched and the utility of the limb is seriously impaired, the open operation holds out the only hope of helping the patient, although it is always a matter of considerable difficulty. The fibrous tissue must be dissected away, and the surfaces of the fragments freshened, if need be, with the saw. To obtain apposition, the upper fragment must be freely detached from the femur, to which it is very often adherent, and the rectus muscle, which is secondarily contracted, may need to be partially divided. The limb should be well raised to relax the quadriceps and thus diminish tension on the bond of union, and lowered inch by inch on succeeding days. The muscle is thus stretched to accommodate itself to the altered conditions.

If the fragments cannot be absolutely brought together, the same treatment may be adopted, and the patient allowed to get about with silver wires between the fragments, the quadriceps is stretched by this means, and a subsequent operation may prove successful in gaining bony union.

### Fractures of the Leg

**Fractures of the Tibia alone**—Several varieties are described  
(a) The upper end is usually broken as a result of direct violence, the fracture being often comminuted. The characteristic features are

not always very evident at first, since considerable swelling and ecchymosis are produced. Occasionally as a result of falls on the heel a T-shaped fracture occurs, the tuberosities being broken off and the upper end of the shaft impacted into one or both of them. A few cases of vertical separation of one of the tuberosities alone are also on record. **Treatment** consists in placing the limb upon a back splint, *e.g.*, Macintyre's, with the knee bent, and, as a rule, satisfactory union ensues, though possibly with some distortion. (b) *Fracture of the shaft of the tibia*, apart from the fibula, is usually caused by direct violence. It is transverse in the upper part of the bone, and oblique below (Plate VI). The fracture is diagnosed by feeling an inequality on running the fingers along the shin, together with pain at this spot on firmly grasping the bones above and below. There is often but little displacement, since the fibula acts as a splint, but the lower end of the upper fragment, which is usually pointed, is tilted forwards by the action of the quadriceps and may pierce the skin. The **Treatment** consists in the application of back or side splints (Chene's) for a few days until the swelling has gone down, and then the limb may be put up in plaster. If the bone has been comminuted, treatment will be more protracted. (c) *The internal malleolus* is occasionally separated as the result of direct injury, apart from any other osseous lesions, constituting what is known as 'Wagstaffe's fracture'. There is comparatively little displacement, but the malleolus is loose, and crepitus can usually be obtained on moving it backwards and forwards. Union by fibrous or osseous tissue ensues, but usually in a more or less abnormal position, in consequence of which the integrity of the ankle-joint is disturbed, and weakness or lameness may follow. **Treatment** consists in the application of lateral splints. If there is any difficulty in keeping the parts in apposition, an incision should be made, and the malleolus wired or pegged to the tibia.

**Fractures of the Fibula alone** are by no means uncommon, usually occurring as a result of direct violence. There is no displacement or deformity, but the patient complains of pain localized to some particular spot, and this can usually be elicited by grasping the bones above and below, and compressing them laterally ('springing' the fibula). Sometimes the diagnosis is extremely uncertain, and then the X rays prove useful. **Treatment** consists in immobilizing the limb in a plaster case.

**Fracture of both Tibia and Fibula** is a very common accident, due to both direct and indirect violence, ~~if to direct violence any part may be injured~~, both bones yielding at the same level, but if in consequence of an indirect injury, the tibia usually gives way at its weakest part, *viz.*, at the junction of its middle and lower thirds, and the fibula at a slightly higher level. The fractures are often oblique, running in any direction according to the character of the violence, although the obliquity is most frequently directed downwards, forwards, and inwards. The lower fragment is generally drawn upwards on account of the contraction of the powerful calf muscles, and often

rotated outwards from the weight of the foot, hence there is well-marked shortening, which can usually be overcome by traction. The ordinary characteristics of a fracture are very evident, and but little difficulty can ever be experienced in making a diagnosis. The fracture is likely to become compound when due to indirect violence, owing to the sharp end of the oblique fragment of the tibia, usually the upper, piercing the skin. Skiagraphy is exceedingly useful in enabling one to decide as to the character of the lesion, and the skiagrams should be taken both from the front and from the side, as the appearances are often very different (compare Plates XXI and XXII).

The fracture of the tibia has been proved by skiagraphy to be frequently of the *bec-de flûte* type, and is then probably always due as much to forcible torsion of the limb as to vertical strain. The rotation is a very important element in these cases, and the lower end of the upper fragment rides prominently forwards (the 'riding fragment'). The shortening is sometimes less marked than in simple oblique fractures, but there is much greater difficulty in getting satisfactory approximation of the fragments, even after freeing the ends of the tibia by operation. This difficulty is probably in most cases due to the broken ends of the fibula becoming engaged in the fibro-muscular tissues around it, and will necessitate an incision over this bone in order to free them.

**Treatment**—In the simpler cases reduction is accomplished by flexing and fixing the knee, so as to relax the muscles of the calf, and then making traction on the foot and manipulating the parts into position. The tendo Achillis may, if necessary, be divided. It will usually suffice to put up the limb in a pair of side-splints, such as Cline's, the longer one with the foot-piece being intended for the outer side. In other cases it may be better to apply a broad posterior splint with a rectangular foot-piece, *e.g.*, Macintyre's, and two lateral splints, or the old-fashioned half-box splint may be employed. Some surgeons recommend an anterior wire splint, extending from above the knee to the foot, the leg being subsequently slung in the flexed position. This may be advantageously modified by combining it with an additional casing of plaster of Paris. Whatever treatment is adopted, it is necessary to see that the length of the limb is as far as possible maintained, and that no rotation of the lower fragment is present. To ensure absence of rotation, all that is needed is to note that the inner aspect of the great toe, the subcutaneous surface of the internal malleolus, and the inner border of the patella, are in the same line, and correspond with the opposite limb. Union will be sufficiently advanced in two or three weeks at the latest to allow of the limb being put up in plaster, which must be retained for at least another month, and even then a good deal of lameness is likely to persist, which will need subsequent massage. In oblique and spiral fractures there is often very great difficulty in getting the fragments together, and even more in maintaining them in good position. Taking into consideration the degree of permanent depreciation that a man (especially if of the labouring classes) suffers from vicious

PLATE XXI.

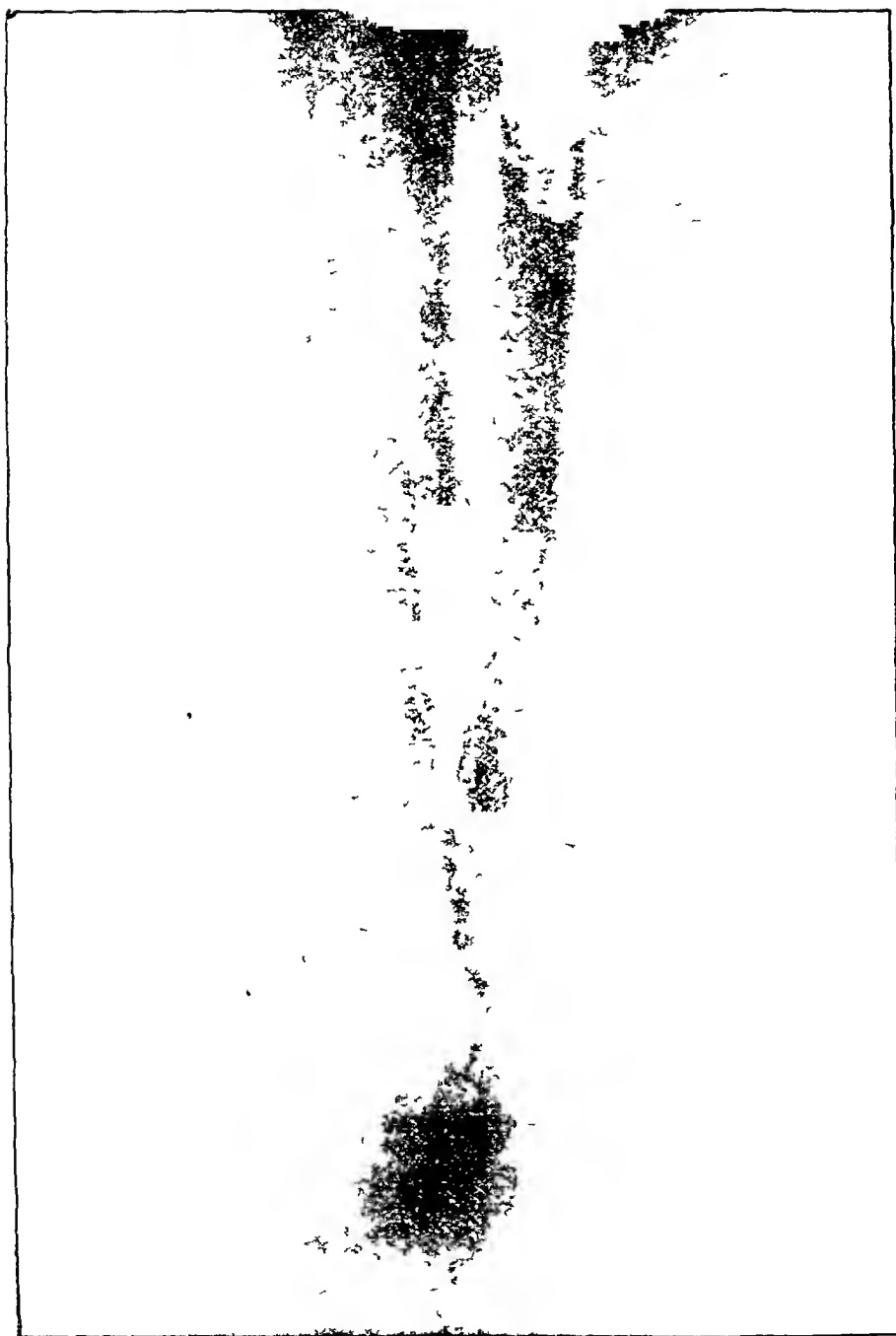


FRACTURE OF BOTH BONES OF THE LEG, SEEN FROM IN FRONT





## PLATE XXII



THE SAME FRACTURE AS IN PLATE XXI, SEEN FROM THE INNER SIDE  
From a study of the two skiagrams it will be noticed that both lower fragments have been displaced outwards, with but little alteration in their antero-posterior axes



union of these bones, we have no doubt that the suggestion to cut down on, and wire, screw, or peg the fragments together, is fully justifiable in the hands of skilled surgeons. In the spiral cases the operation may also have to include an incision to free and fix the fibula.

Fractures in the neighbourhood of the Ankle-joint are usually produced by indirect violence, the foot slipping, and leading primarily to a displacement of the ankle, the fracture being a secondary result. They would therefore be better described as Fracture-dislocations at the Ankle-joint.

1. *Displacement of the Foot outwards* is by far the most common variety, resulting usually from the patient slipping on the inside of the foot, as from off a kerbstone. Several distinct varieties of lesion are now recognised.

(a) In *Pott's Fracture*—(Plate XXIII) sudden abduction of the foot results in severe strain upon the internal lateral ligament, which gives way, or the base of the internal malleolus is torn off. The astragalus is thereby driven against the inner aspect of the external malleolus, and tends to displace that portion of bone outwards. The force is thence transferred up the fibula, which bends and breaks at its weakest spot—that is, about three inches above the tip of the malleolus—the upper end of the lower fragment being displaced inwards towards the tibia. The inferior interosseous tibio-fibular ligament remains intact, and hence the foot itself is merely rotated outwards or abducted, and the heel is drawn upwards, whilst the toes point downwards. If the ligament alone is torn, the malleolus projects beneath the skin, and may, indeed, protrude through it, there is always much bruising and ecchymosis on the inner side of the ankle. If the malleolus itself is torn off, a distinct sulcus can usually be felt between it and the lower end of the tibial shaft. In both these types the ankle-joint is necessarily laid open, and there is probably much hæmorrhage into neighbouring tendon sheaths.

(b) In *Dupuytren's Fracture* a much more serious lesion is produced. The interosseous tibio-fibular ligament yields more or less completely, or the flake of bone to which it is attached is torn off, the foot, carrying with it the lower portion of the fibula and the superficial flake of the tibia, which has been detached, is displaced firstly outwards, and so long as the upper surface does not clear the lower articular surface of the tibia, there is merely lateral displacement with marked abduction of the foot and increased breadth of the ankle (Plate XXIV). Should the force continue to act, the astragalus may be carried sufficiently outwards to clear the lower end of the tibia, and then an upward and to a less degree a backward displacement is added, causing great eversion of the foot and deformity of the ankle. On the inner side either the ligament or the malleolus may yield.

(c) In another variety the injury consists in the usual type of fracture of the fibula, associated with an almost transverse fracture of the tibia, just above the base of the inner malleolus (Plate XXV). In this form, the lower end of the shaft of the tibia projects beneath

the skin, and is likely to be mistaken for the tip of the malleolus, if this error is committed, and the fracture allowed to unite without proper reetification, considerable deformity results. In rare instances, the lower end of the tibia may project through the skin, thus rendering the fracture compound.

(d) A similar injury in children may produce a separation of the lower epiphysis of the tibia, whilst the fibula yields in the usual situation. The line of separation in the tibia is more or less transverse, but may extend into the diaphysis on the outer side.

In almost all of these varieties the ankle-joint itself is opened, and this, combined with the amount of bleeding that occurs into tendon sheaths and muscles around, and the difficulties often associated with fixation of the fragments, explains why the results of these cases are frequently so unsatisfactory. Should union occur with the foot in a false (*i.e.*, everted) position, a large mass of callus develops between the shaft of the tibia and the malleolus.

2 *Displacement of the Foot Inwards*—When the patient slips on the outer aspect of the foot, the astragalus is forcibly driven against the

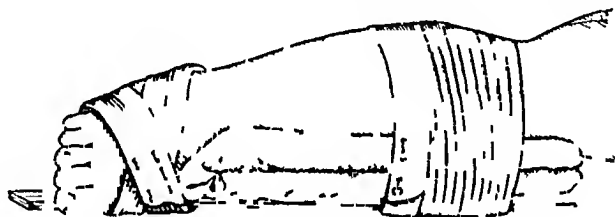


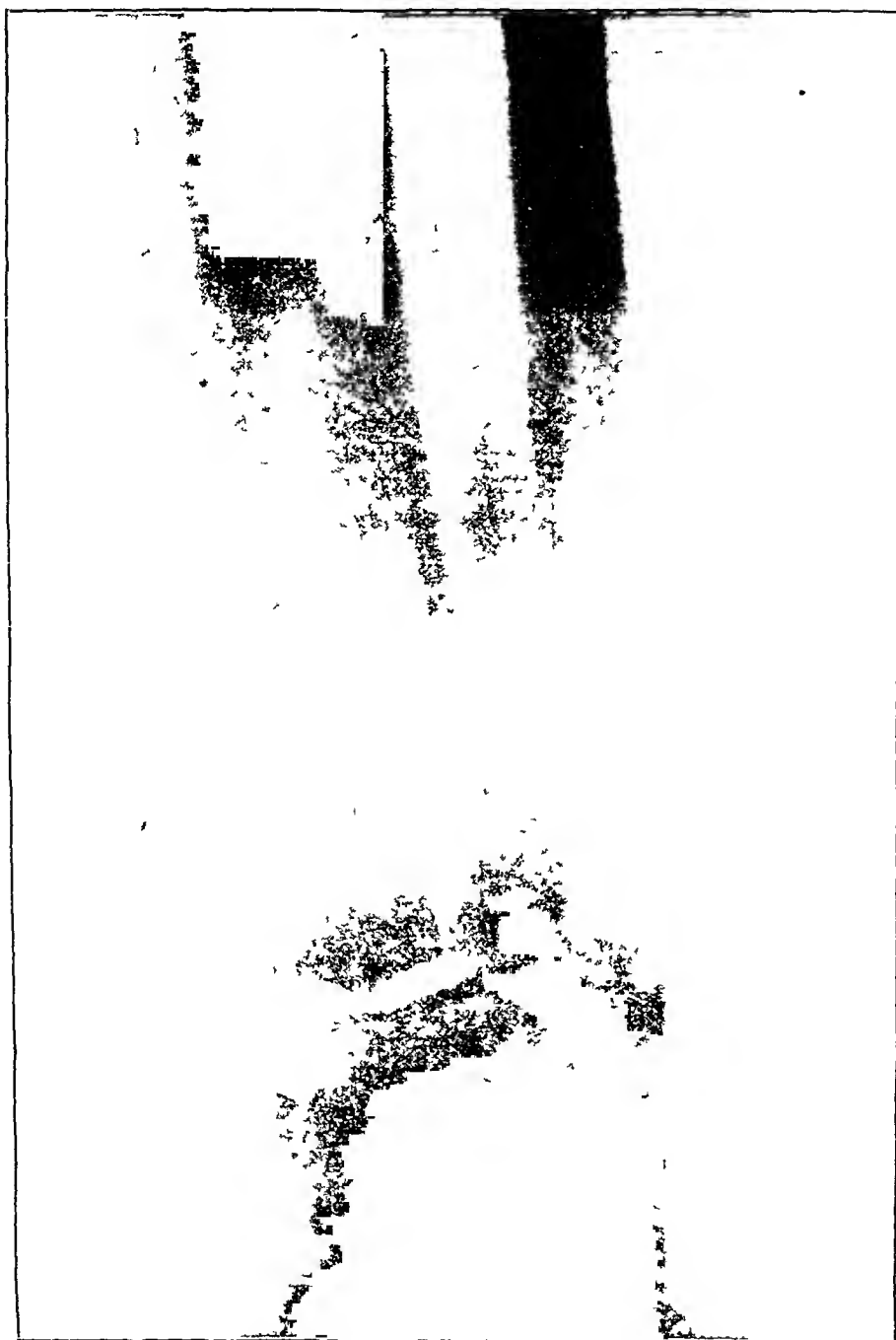
FIG. 190.—DUPUYTREN'S SPLINT APPLIED FOR POTT'S FRACTURE (TILLMANN'S)

inner malleolus, which may be broken off or impacted into it. The outer malleolus is dragged inwards with the foot, and owing to the integrity of the inferior tibio-fibular ligament, which acts as a fulcrum, the fibula yields at the same spot as in Pott's fracture. The foot is displaced inwards, and perhaps slightly backwards.

3 *Displacement of the Foot backwards*, by catching the heel and tripping forwards, is usually associated with fractures of the tibia and fibula in the same position as in Pott's fracture, but eversion of the foot is absent (see dislocation of the ankle backwards, p. 643).

**Treatment**—In reducing these fractures, traction should be made upon the foot after the tension of the calf muscles has been relieved by flexing the knee, or by tenotomy of the tendo Achillis, the position of the internal malleolus must be accurately defined. Before applying the splints, careful attention must be given to the following points:—(a) The foot must be maintained at right angles to the leg, (b) the heel must not project unduly backwards, and (c) the foot must not be rotated on the leg—*i.e.*, the inner surfaces of the great toe, internal malleolus, and patella must be in the same line. A pair of Cline's splints is often sufficient to steady the parts in simple cases. Some patients are better treated, however, by a Dupuytren's splint (Fig. 190), which is really a Liston's splint on a small scale. It reaches from the

PLATE XXIII

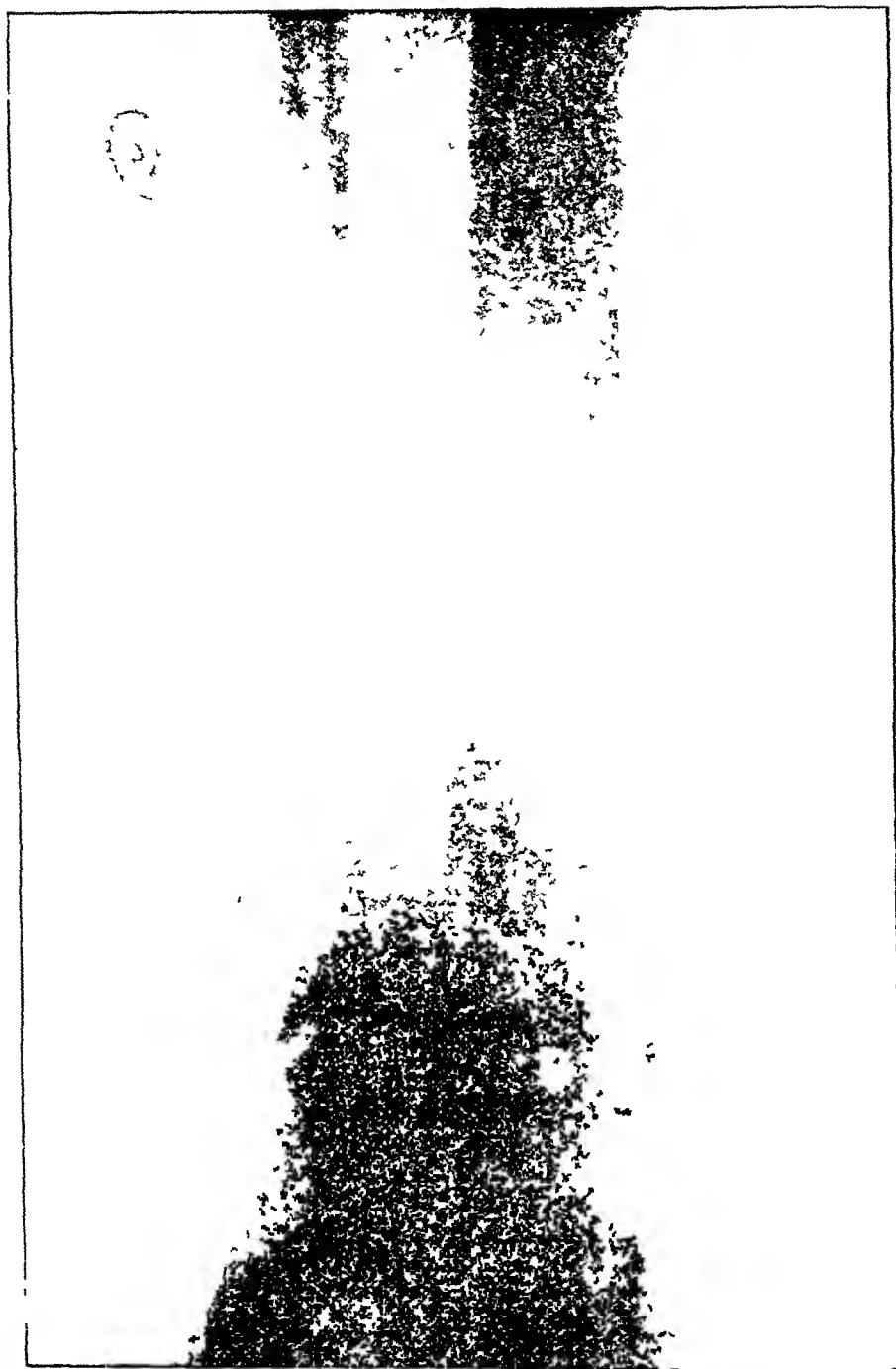


POTT'S FRACTURE, SHOWING SEPARATION OF INTERNAL MALLEOLUS AND FRACTURE OF FIBULA

(For the loan of the negative from which this plate was prepared we are indebted to Mr Caldwell, of 62 Welbeck Street )



PLATE XXIV

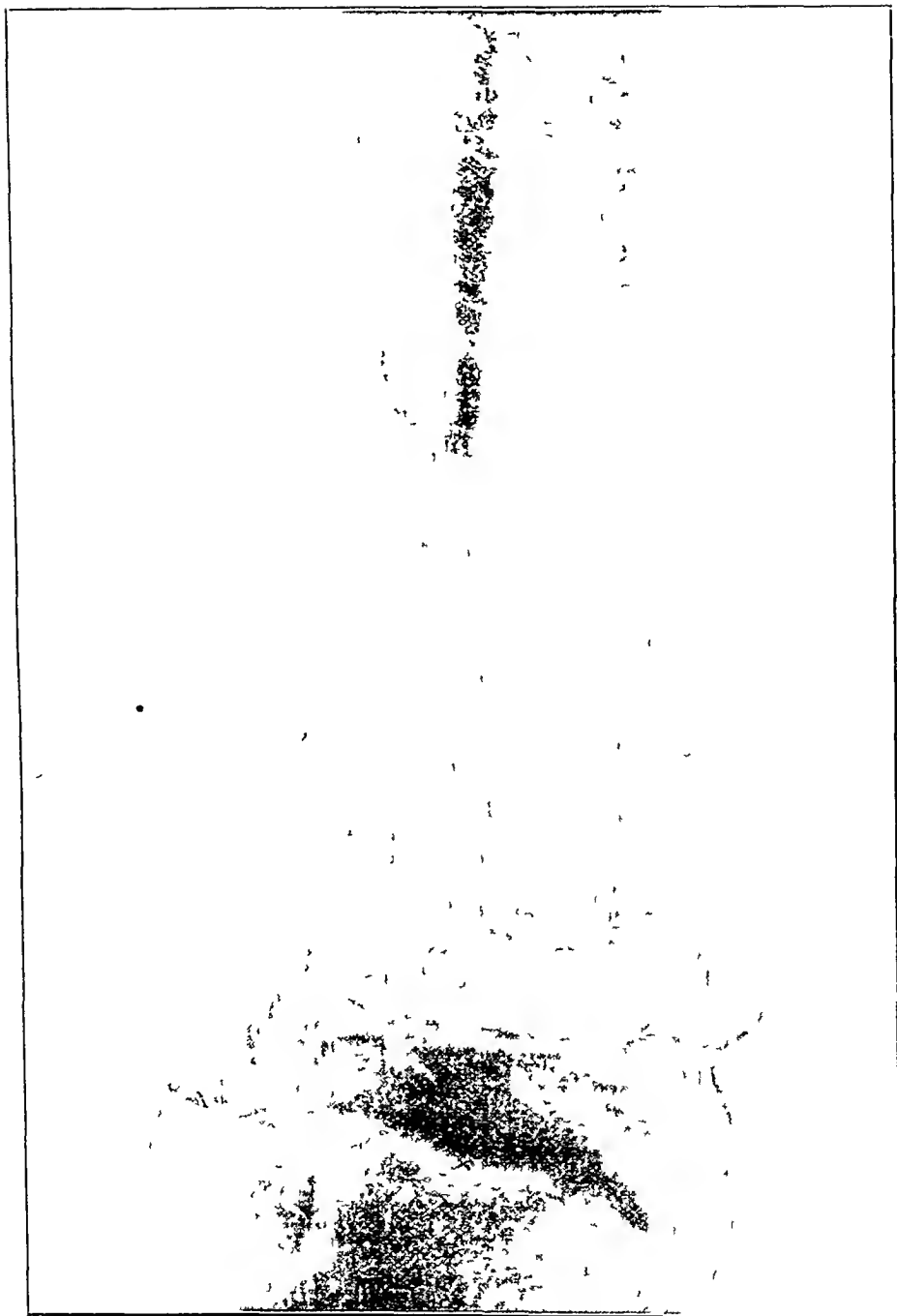


DUPUYTREN'S FRACTURE, WITH WELL-MARKED DISPLACEMENT OUTWARDS OF THE FOOT, AS WELL AS OF THE LOWER FRAGMENT OF THE FIBULA AND THE INTERNAL MALLEOLUS (SKIAGRAM TAKEN FROM IN FRONT)





PLATE XXV



SEPARATION OF LOWER EPIPHYSIS OF TIBIA ASSOCIATED WITH FRACTURE OF FIBULA AT THE USUAL SITE OF A POTT'S FRACTURE, WHICH IS THEREBY CLOSELY SIMULATED (Mr A D Reid)



knee to below the sole of the foot, and is placed on the inner side of the limb, the patient lying on the sound side during its application. A firm pad extends down as far as the base of the internal malleolus, and over this as a fulcrum the foot is drawn inwards by a handkerchief applied around the ankle, and tied to the notches at the end of the splint. The foot being thus fixed, the upper end of the splint is bandaged to the limb. Any tendency to backward displacement of the heel may be counteracted by the use of a Macintyre's back-splint, or by the application of a Syme's anterior horseshoe splint, which can be used in combination with a Dupuytren. It consists of a flat piece of wood, well padded, extending from the knee to the ankle along the crest of the tibia, the lower end is shaped like a horseshoe, the two limbs passing one on either side of the foot. A handkerchief or piece of bandage is applied, with its centre over the point of the heel, it passes up on either side between the splint and the foot, winds over the former structure, and is tied behind the heel, which is thus lifted forwards. As soon as possible, the limb should be put up in water-glass or plaster of Paris.

In the simpler forms, early massage may be employed, and then all the retentive apparatus necessary is some adhesive plaster applied so as to cover in and encase the foot and ankle. In the more difficult cases, where there is considerable displacement and much difficulty in keeping the fragments together, operation to fix them is quite justifiable.

In cases of vicious union after Pott's fracture, it is usually necessary to redivide the fibula, and to excise a V-shaped portion of bone from the tibia extending into the ankle joint, so as to enable the malleolus to be brought in contact with the shaft.

**Fracture of the Os Calcis** may result from direct violence, such as a blow or fall on the heel, or possibly from muscular action, the epiphysis being then separated, or the shell of bone into which the tendo Achillis is inserted being torn off. The fragment thus separated is displaced upwards by the contraction of the calf muscles and the resulting deformity is very evident. If the line of fracture passes through the body of the bone there may be no displacement, owing to the attachment of the interosseous and lateral ligaments, but should the sustentaculum tali or greater process be broken, the arch of the foot may be more or less flattened. When due to a fall from a height, the bone is often comminuted and the foot much bruised and swollen. **Treatment** consists in immobilizing the foot in a plaster case if there is no displacement, but where the posterior part of the bone is drawn upwards, it must be approximated to the rest of the bone after flexing the leg, in order to relax the calf muscles, or possibly after tenotomy. A more satisfactory result may, however, be obtained by cutting down, and wiring or pegging. In fractures which are likely to be followed by traumatic flatfoot, the patient must not be allowed to walk without an effective metal instep support.

**Fracture of the Astragalus** is usually due to falls on the foot from

a height, or from direct violence applied to the foot, as by a weight falling upon it. The lesion is often a severe comminuted one, and portions of the bone may be displaced forwards or backwards, making a marked projection beneath the skin. In a case recently under our care at hospital, the patient had fallen down a lift, alighting on his feet, both astragali were smashed, and this probably saved his life. Such accidents are often associated with lesions of the tibia or fibula, and possibly even of the femur. The whole region of the ankle becomes infiltrated with blood, and an exact diagnosis is sometimes difficult. **Treatment** consists either in immobilization, which is likely to be followed by stiffness of the ankle, or in bad cases by excision of the bone or of projecting fragments.

Occasionally in less severe accidents the bone merely splits across, the lesion being usually situated about the neck. Such is due either to the weight of the body flattening out the arch of the bone beyond the limits of elasticity, or, if the foot is dorsiflexed, to penetration of the bone by the anterior edge of the tibia, impaction being even produced in this way. Massage and early mobilization should be employed in such cases.

Other bones of the tarsus are occasionally fractured, but these lesions require no detailed description.

## CHAPTER XX

### DISEASES OF BONE

#### Inflammation of Bone

**General Considerations** —Bones are divided into the long, the short, and the flat, each of these consisting of compact and cancellous tissue. In the short bones there is but a thin layer of compact tissue surrounding a cancellous central mass, the meshes of which are filled with medullary fat and connective tissue. In the flat bones the compact tissue forms two limiting plates, separated by a layer of cancellous tissue (known in the skull as the diploe). In long bones the shaft consists of a tube of compact structure, surrounding a space which is normally filled with medulla, and known as the medullary canal, at each end it gradually merges into a larger mass of loose cancellous tissue, the interstices of which are similarly packed with vascular fatty medulla, which apparently performs the function not only of maintaining the nutrition of the bone, but also of elaborating the blood. Prolongations from the medulla extend into the Haversian canals, and are thence continuous with the periosteum, so that the mineral skeleton has incorporated within it a vascular fibro-cellular mass which permeates its whole structure.

The *vascular supply* of a bone is derived (*a*) from the nutrient artery which passes into the medullary space, and there breaks up into branches which ramify through the whole of the medullary tissue, and thence extend into the Haversian canals, and (*b*) from the periosteum, an exceedingly vascular ensheathing membrane, from which small vessels pass perpendicularly into the Haversian canals, and establish a communication between the two systems. These latter vessels are especially numerous and large close to the epiphyses. Large veins occur in the medullary and cancellous interior, and are frequently thrombosed in inflammatory mischief, if the thrombus becomes infected, and so disintegrated, pyæmia is very likely to ensue.

The *growth* of bone manifests itself in three different directions. (1) It increases in length from the shaft side of the epiphyseal cartilage, the epiphysis itself growing but little. In the upper limb the chief increase in length occurs at the shoulder and wrist, whilst in the leg it is mainly evident on either side of the knee-joint, and this in spite of the fact that the so called nutrient arteries are directed away from

these points (11) Increase in breadth is produced by new formation of bone from the deeper layer of the periosteum, which contains many yellow elastic fibres, and a large number of angular nucleated cells, or osteoblasts, which are presumably the bone-forming agents (111) A bone increases in density by a new deposit of osseous tissue around the Haversian canals and cancellous spaces

In considering the inflammatory affections of bones, it must always be kept in mind that the essential pathological phenomena (*viz*, hyperæmia, exudation, and tissue changes, active or passive) are similar to those manifested in any other vascular structure, but that the resulting effects are modified by the limited space in which the vessels lie, and the resisting character of the surrounding osseous tissue Hence any *acute* inflammation, associated with rapid vascular engorgement and considerable exudation quickly poured out, leads to *necrosis* from thrombosis, due to increased pressure within the unyielding bony canals If, however, the process is *subacute*, so that the tissue-liquefying properties of the exudation and the tissue absorbing activity of the leucocytes can come into play, then *osteo-porosis* or *rarefaction* of the bone follows, a condition sometimes termed *caries* On the other hand, if the inflammation is *chronic*, and due to causes other than tubercle or the pressure of tumours, then new formation occurs, and *osteo-sclerosis*, or condensation, is most likely to result Tubercle in bones, as elsewhere, causes primarily rarefaction of the tissue attacked, though sclerosis may be associated with or follow it, and the chronic pressure of tumours or aneurisms leads to rarefaction and atrophy locally, although a certain amount of sclerosis may be induced around

Much needless confusion has arisen in connection with the *terminology* of inflammatory affections of bone To all of them, whatever their nature or position, the term 'osteitis' might rightly be applied, but when the medullary cavity of a long bone is particularly affected, the term 'osteo-myelitis' is substituted, as also sometimes when masses of cancellous tissue, as in the os calcis, or sheets of it, as in the diploe of the cranial bones, become the seat of an acute inflammation The vascular continuity between the periosteum and medulla through the Haversian canals will explain why a periostitis is always associated with osteitis of the underlying bone, and why an osteomyelitis is never strictly limited to the medullary cavity

It is also important to realize that necrosis, caries, and sclerosis are results of inflammation, and must neither be confounded with the pathological processes leading to them, nor described as distinct diseases

Necrosis, or death of bone, may occur in a variety of forms, and from many different causes, *e g* (a) From acute localized suppurative periostitis, the sequestrum or dead mass being then simply a superficial plate or flake of the compact exterior (Fig 191), (b) from acute infective osteomyelitis, the sequestrum then often involving the whole thickness of the bone, and invading more or less of the length of the diaphysis, if the condition is not early and efficiently

treated (Figs 193 and 194), (*c*) from acute or subacute septic osteitis of cancellous bone, the sequestra being small spiculated fragments of the bony cancelli which have escaped absorption by the granulation tissue always forming in such a process, (*d*) from tuberculous disease of cancellous tissue, the sequestrum being light and porous, often infiltrated with curdy material, and rarely separated completely from surrounding parts, (*e*) from syphilitic disease of cancellous or compact tissue, usually resulting from excessive sclerosis, or gummatous disease of the periosteum which has become septic, (*f*) from the action of local irritants, *e g*, mercury, or phosphorus fumes gaining access to the interior of the teeth, (*g*) occasionally as a simple senile loss of nutrition, as in senile gangrene, and (*h*) a variety, described by Sir James Paget under the name of 'quiet necrosis,' occurs as a result of direct injury, the sequestrum separating without suppuration, it is one of the causes of loose bodies in joints, and especially the knee, following a blow on one of the condyles

The separation of sequestra is always brought about by a process analogous to that by means of which sloughs and gangrenous materials are cast off from the body, viz, by complete absorption if small, aseptic, and surrounded by sufficiently vascular tissue, by absorption of as much as possible, in larger aseptic masses, granulation tissue invading and replacing the dead mass, and a line of separation forming as a result of defective nutrition of the most advanced layer, or, if septic, an active rarefying inflammation occurs in the neighbouring living tissue, which in time breaks down, and so sets free the dead mass (See in more detail at p 96) From the eroding action of the granulation tissue, the under surface of the sequestrum is always hollowed out, and, as it were, worm eaten in appearance. Where sepsis is present, the process is more active, and is completed more rapidly, though with greater risk to the patient

**Caries**, or, as it is sometimes called, *osteo porosis*, or *rarefaction of bone*, is a clinical condition resulting from inflammation, and consisting in a soft and spongy state of the bone, which, if it can be reached, readily breaks down on pressure with a probe. It may result from the following conditions (*a*) A simple subacute inflammatory process, *e g*, during the early stage of repair in a fracture, (*b*) from acute or subacute septic or infective inflammation of cancellous tissue, (*c*) from tuberculous affections of the cancellous tissue or periosteum, (*d*) from syphilitic disease of the medulla or of the under surface of the periosteum

Pathologically, it is characterized by the replacement of the medulla by granulation tissue, which usually contains some large multi-nucleated cells, or *osteoclasts*, and these seem to be closely connected with the removal of the bone. The cancellous tissue becomes hollowed out to accommodate these granulations, and the osteoclasts are usually found occupying shallow depressions known as 'Howship's lacunæ'. In tuberculous and syphilitic lesions the bone corpuscles often undergo fatty degeneration

Caries may occur with or without suppuration (*C sicca* or *suppura-*



*tiva*), sometimes the development of granulation tissue is excessive, as when it fungates from the articular end of a bone into a joint (*C fungosa*). Not unfrequently it is associated with necrosis, constituting a condition of *cario-necrosis* (or *C necrotica*), as in septic inflammation of cancellous bone, minute spiculated sequestra being found in the discharge, whilst in tuberculous osteitis dead portions of larger size often occur. In fact, caries and necrosis bear much the same relation to one another as ulceration and gangrene of the soft tissues.

If caries is recovered from, a subsequent condition of sclerosis usually follows, with loss of substance and often deformity.

**Sclerosis** of bone (osteo-sclerosis) is invariably the result of some chronic inflammatory affection, *e g*, (a) chronic periostitis, whether simple or syphilitic, (b) chronic osteo-myelitis, simple, tuberculous, or syphilitic, or (c) chronic osteitis of the compact bone, which is always secondary to one of the former. In all cases the condition is due to a slow formation of new bone within the Haversian canals or cancellous spaces, thus diminishing their lumen, in syphilis this may progress to such an extent as to lead to their total occlusion, and even to localized necrosis from lack of blood-supply, especially when sepsis has occurred. In tuberculous bones the sclerosed tissue is always at some distance from the focus of mischief, and may be looked on as Nature's attempt to limit the spread of the disease, it forms also the final tissue or bone-scar in the process of repair in those cases where a cure has been obtained by natural or surgical means.

### Classification of Inflammatory Affections of Bone

#### I Periostitis

- (a) Acute localized, with or without suppuration
- (b) Acute diffuse, always associated with or secondary to acute infective osteo-myelitis
- (c) Chronic simple, or hyperplastic
- (d) Chronic tuberculous
- (e) Chronic syphilitic

#### II Osteitis, or inflammation of *compact* bone, which is always associated with and secondary to either periostitis or osteo-myelitis, and so will not be described separately. The acute form results in necrosis, the subacute in osteo-porosis, and the chronic in sclerosis, except in tuberculous disease.

#### III Osteo-myelitis, or inflammation of the medulla of long bones

- (a) Acute infective
- (b) Subacute simple or infective, *e g*, during the separation of sequestra, resulting primarily in rarefaction, but finally in sclerosis
- (c) Chronic simple, tuberculous or syphilitic, usually causing general enlargement and sclerosis of the bone, even if locally some rarefaction is present

IV Inflammation of the Cancellous Tissue (Osteitis) may similarly be

- (a) Acute infective
- (b) Subacute simple or septic
- (c) Chronic simple, syphilitic, or tuberculous

When limited to the articular end of a bone in a young person, this is sometimes termed **Epiphysitis**

It is unnecessary to describe in detail all these conditions, since many of the divisions overlap, and hence we shall group together the various acute and chronic affections in order to indicate the clinical signs and symptoms

#### ACUTE INFLAMMATIONS OF BONE

1 **Acute Localized Periostitis** usually arises as a result of traumatism applied directly to the bone, with or without an open wound, it may

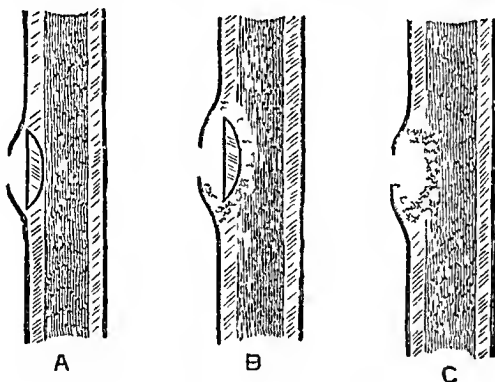


FIG 191—SUPERFICIAL NECROSIS RESULTING FROM A LOCALIZED PERIOSTITIS (DIAGRAMMATIC)

A represents the necrosed tissue lying in continuity with the surrounding living bone, the periosteum is stripped up from it, and has an opening through which the pus has been discharged. B shows a later stage, in which the sequestrum is being separated by a process of rarefying osteitis in the immediately contiguous living bone, whilst an involucrum, or sheath of new bone, is formed from the under surface of the periosteum, a cloacal aperture remains in the involucrum for the escape of discharges. C shows the condition of affairs after the sequestrum has been removed.

also be determined by general conditions, such as rheumatism, gout, and pyæmia, or by an extension of inflammatory mischief, as in an alveolar abscess

**Pathologically**, the process consists of hyperæmia of and exudation into the periosteum, which becomes swollen, turgid, and thickened. This may be followed in due course by resolution, or may leave the bone thickened and in a condition of chronic inflammation, or supuration may ensue, and with it usually a limited superficial necrosis. In the last event pyogenic organisms of no great virulence must find an entrance to the area of mischief, and probably in cases due to trauma through the abraded or injured skin, in other instances they

may come from neighbouring foci of inflammation, or possibly auto-infection may occur. The inflammatory process extends to the small vessels entering the bone from the under surface of the periosteum, these become dilated, next thrombosed and strangled by the pressure of the exudation around them, and finally pulled out from the osseous canals by the tension of the subperiosteal effusion and by the peptonizing power of the bacterial products. Consequently, the vitality of the superficial layer of bone is destroyed for an area corresponding almost exactly to that from which the periosteum has been stripped (Fig 191, A)

As soon as tension has been relieved by the escape of the pus, repair commences. Where the mischief is very slight and superficial, the involved bone may entirely recover, or even small necrotic portions be absorbed. If the dead portion of bone is more extensive, it will be separated from the subjacent living tissues by one of the processes already described (p 96), whilst from the under surface of the stripped up periosteum a casing of new bone is developed, constituting an *involucrum* or sheath, at first spongy and cancellous in texture, but finally hard and sclerosed. In the centre of this new formation are found one or more openings or *cloacæ* through which the discharge passes, and corresponding in position to the openings in the periosteum and skin made by Nature or the knife (Fig 191, B)

Clinically, the symptoms of acute localized periostitis consist in the ordinary phenomena of acute inflammation, the pain being of an intense aching character, worse at night, and increased by lowering the limb or by any kind of pressure. If a subcutaneous portion of bone is involved, a painful swelling develops, at first brawny in character, but when suppuration has occurred the centre softens, whilst the skin over it becomes red and œdematous. When an abscess has burst or been opened, bare bone is felt beneath the periosteum, and the greater part of this denuded structure usually dies, and must then be either absorbed or separated, in either case a sinus remains for a time, leading down through a cloaca in the involucrum to the sequestral cavity. From this either pus or serum will be discharged, according to whether the wound has become septic or not. In about five or six weeks' time the sequestrum is loose, and this may be ascertained by moving it with a probe within the osseous cavity, which is now lined on the inner aspect with granulation tissue.

**Treatment**—Rest, elevation of the limb, leeches, and fomentations are usually relied on locally in the early stages, whilst a good purge and specific anti diathetic remedies may be used generally. If, however, the affection is not readily checked, and suppuration threatens, a free aseptic incision down to the bone is the best means of preventing necrosis. Should an abscess form, it must be opened early, and possibly by this means death of the bone may be obviated or limited. When necrosis has occurred, the parts must be carefully dressed and kept aseptic, until the sequestrum is detached. An incision is then made over the involucrum, the periosteum stripped from it, one of the cloacæ enlarged, and the dead bone removed. The cavity will

now rapidly fill up with granulations, and heal completely. In many cases recovery may be expedited by chiselling away those portions of dead bone, which must ultimately be separated, without waiting for the tardy process of Nature, this should not be undertaken until the destructive changes have ceased, and then only to a limited extent. The dead bone is recognised from the living by its white appearance and by not bleeding when cut.

2 Acute Infective Osteomyelitis (*Syn.* Acute Necrosis, Acute Diffuse or Infective Periostitis, Acute Diaphysitis, Acute Panostitis) — This disease usually occurs in children, often of a tuberculous inheritance, and not unfrequently follows one of the exanthemata (*e.g.*, measles or scarlet fever). It generally commences before the age of puberty, and is an affection of the gravest import, the multiplicity of names attached to it suggests quite accurately that its manifestations may be very diverse in character.

**Pathology** — The patients are always in a state of depressed general health, so that their germicidal powers are considerably diminished. Moreover, spots of localized ulceration are often present in the throat, mouth, or intestines, which give a ready entrance for micro organisms into the system. Evidently some of these must be circulating within the blood, ready to attack any area of diminished tissue resistance. A slight injury in the shape of a strain or a wrench, which is often entirely overlooked or forgotten, may suffice to determine the commencement of an inflammatory process which rapidly spreads by continuity of tissue, until perhaps the whole structure of the bone may be affected.

The majority of the ligaments and not a few tendons are inserted into the epiphysis, and hence articular strain must be mainly felt in the juxta-epiphyseal region, *i.e.*, immediately beyond these insertions. It has been already mentioned that the traumatic separation of epiphyses is liable to be followed by suppuration, even in healthy children, and it is easy to understand that in an unhealthy child a very slight injury in the epiphyseal region may determine a similar process.

The disease almost always starts in the soft vascular tissue on the shaft side of the epiphyseal cartilage, but occasionally it commences in the epiphysis itself at the margin of the ossifying centre, and in a few instances (mainly amongst young adults) it may be preceded by a patch of localized periostitis, suggesting that an acute infection has supervened upon a subacute periosteal focus. The bacteria, once admitted, grow and multiply rapidly, and give rise to inflammatory phenomena, the nature and extent of which depend largely on the exact situation of the infective focus, the amount of resistance offered by surrounding tissues, and the virulence of the organisms. As in any other part of the body, the trouble is most likely to travel along the line of least resistance.

1 If the process commences in the periphery of the juxta-epiphyseal region close to the periosteum, the line of least resistance will be towards that structure, and hence a sub-periosteal abscess may form, whilst the central portions of the bone may escape almost

entirely. The extent of this abscess varies, but considerable portions of the diaphysis may be denuded, resulting in extensive necrosis. It rarely extends to the neighbouring joint, owing to the close bond of union which exists between the diaphyseal periosteum and the epiphyseal cartilage. In this variety an early incision to let out the pus may suffice to prevent necrosis, or, at any rate, to limit it. The constitutional symptoms will be less severe than in other varieties, there is less likelihood of the development of pyæmia, and the toxic fever soon disappears after the removal of the pus. Subsequently the same course of events occurs as in the localized variety of acute periostitis—viz., an involucrum forms, perforated by one or more cloacæ, and the sequestrum in time separates.

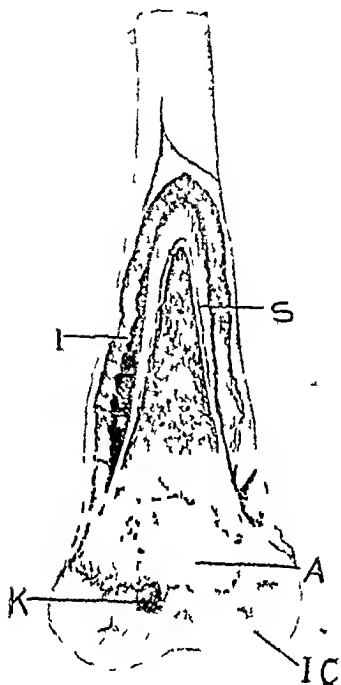


FIG. 192.—ACUTE OSTEO MYELITIS OF THE LOWER END OF THE FEMUR IN A CHILD OF NINE WEEKS (AFTER LEVER.)

IC, Internal condyle, K, centre of ossification in epiphysis, A, abscess cavity in epiphyseal line, S, sequestrum, I, involucrum.

are destroyed, so that an involucrum rarely forms in this particular example of necrosis. Removal of the sequestrum is also difficult, from anatomical reasons, and hence amputation is sometimes required.

2. Should the process start in the centre of the juxta epiphyseal region, it may spread in several directions, and the results vary considerably.

(a) The process may reach the periosteum first, and then the phenomena of a diffuse subperiosteal abscess, as indicated above, with the addition of the symptoms due to its deeper origin, will manifest themselves. This is, perhaps, the most usual course for the disease to take.

(b) If the infection extends along the medullary cavity, the most typical form of osteo-myelitis ensues (Fig 192). The medulla becomes intensely hyperæmic, the veins are thrombosed, localized foci of suppuration and gangrene appear, and in consequence of the increased pressure infective emboli are likely to be detached and pyæmia to follow. Even if the latter does not supervene, the general condition is profoundly affected by the absorption of toxins. Suppuration also occurs beneath the periosteum, although the amount of pus may not be great at first, but the membrane is stripped up from the diaphysis, perhaps to such an extent as to involve the whole length and circumference of the shaft. Unless prompt measures are taken to limit the progress of the disease, necrosis is certain to follow, usually implicating the whole thickness of the diaphysis, and sometimes its whole length. In fact, the diaphysis is occasionally found lying loose in an abscess cavity, the two epiphyses having been detached.

(c) It has been already mentioned that, owing to the intimate connection between the periosteum of the diaphysis and the epiphyseal cartilage, the neighbouring joint usually escapes infection. Should, however, the epiphyseal line be within the joint, as in the hip, it must perforce become the seat of an acute infective arthritis as soon as the bacteria reach its periphery. The elbow-joint is similarly liable to suffer when bacteria attack the upper end of the ulna, since the epiphysis is a mere flake of bone, and the greater part of the olecranon is derived from the shaft. Sometimes the junction cartilage is softened and destroyed by the organisms, so that the inflammation spreads through the epiphysis to the articular cartilage, which is eroded, and the joint opened. Occasionally the pus burrows along the soft tissues outside the bone, as along the biceps groove into the shoulder-joint.

In infants, where there is little or no bone, the cartilage may be rapidly destroyed, and an opening made through it into the joint, giving rise to what was described by Sir Thomas Smith as the acute arthritis of infants.

(d) When the organisms are of a less virulent type, the process may be much more localized and subacute in nature, resulting in a limited central necrosis, or in a chronic abscess inside the bone if the part involved consists of a mass of cancellous tissue, as in the head of the tibia. A similar condition may affect certain epiphyses which occur away from joints, and some chronic abscesses in such situations as the great trochanter may be explained on these grounds. An occasional result of a subacute non-suppurative osteo-myelitis is bending of the affected bone, especially if the patient is able to put any pressure or weight on it.

The organism generally found in this disease is the *Staphylococcus pyogenes aureus*, but occasionally others are responsible for it, and the symptoms vary somewhat with the causative microbe. Thus, if due to the *Staph. pyog. albus*, the process is less acute, a good deal of brawny infiltration of the periosteum ensues, and necrosis is more

easily prevented by early treatment, this variety is sometimes termed 'periostitis aluminosa'. The *Streptococcus pyogenes*, if present at all, is only found in young children, and the resulting necrosis is often less extensive. The *Pneumococcus* has also been frequently discovered in this disease in children, as well as the *B. coli*, which latter only occurs in association with other organisms, the resulting pus is very foul.

**Clinical History** — The disease usually commences abruptly with a rigor, followed by high fever and severe pain in the limb, which soon

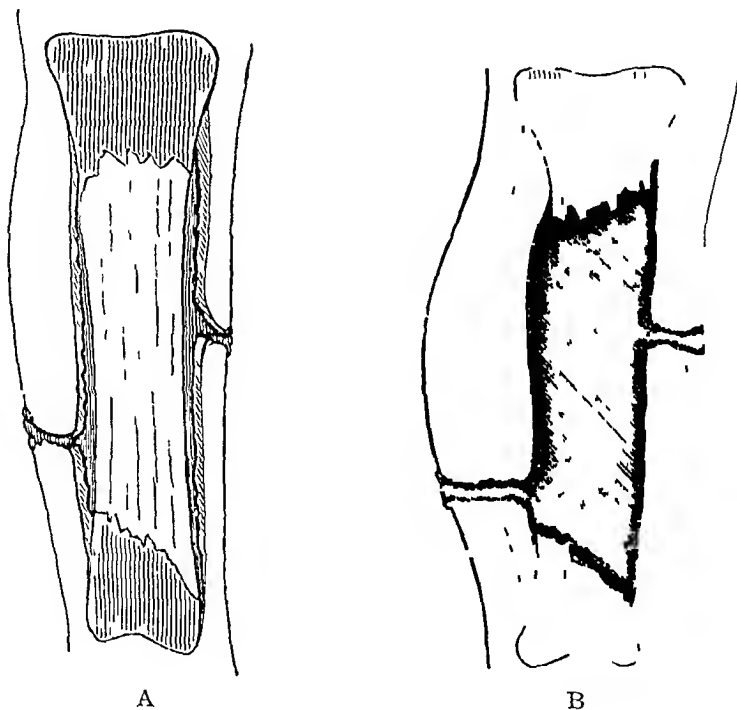


FIG 193 — DIAGRAM OF MASSIVE NECROSIS AFTER ACUTE OSTEO MYELITIS (BILLROTH)

In A (early) the necrosed tissue, though continuous above and below with the healthy bone, is surrounded by a cavity formed by the stripping up of the periosteum, and from it two sinuses pass to the exterior, in B (late) the sequestrum is supposed to have been loosened and removed, and the cavity remaining is lined by granulation tissue, and surrounded by a thick involucrum of new bone, in which two cloacae exist.

becomes swollen, brawny, and congested. It may at first be mistaken for an acute attack of rheumatism, although the fact that the inter-articular portion is affected, and not the articulation, should readily prevent this error. The pain is of an extremely severe nature, so that the child screams whenever the limb or even the bed is touched.

Should the trouble be mainly limited to the periosteum, evidences of its being stripped off the bone, and of the accumulation of pus

beneath it, soon show themselves. An abscess forms which may quickly transgress its periosteal boundary and burrow under fascial or muscular planes, its limitation to the diaphysis has been already explained, but, although the neighbouring joints may escape infection, they are very likely to suffer from a serous exudation, and subsequently some restriction of movements may be observed. Sooner or later the abscess bursts or is opened, giving exit to a larger or smaller amount of pus, and the subjacent bone is found bare and apparently dead. Possibly the relief of tension may suffice in such cases to limit the mischief, the periosteum again becoming adherent to the bone, and a cure being established without extensive necrosis. More frequently a considerable portion of the shaft loses its vitality, and has to be separated in the manner already described, whilst an involucrum forms around it from the periosteum (Figs 193 and 194). If a mixed infection has not occurred, no fever or bad constitutional symptoms need be expected during this later stage. Sometimes the process is so acute as to cause actual sloughing or disintegration of the periosteum, so that its osteogenetic powers are destroyed, and subsequent repair becomes difficult or impossible.

When the medulla itself is more especially involved, the symptoms of pyæmia or of severe toxæmia become very prominent, and the child may die from this cause before the local mischief has been able to advance very considerably. The pain will continue to be of a severe character, although the patient's perceptions may be so blunted by the toxic condition that it lies more or less unconscious. The swelling of the limb is not so great as in the former type, but the mischief may be very extensive, and although there is no great collection of pus beneath the periosteum, yet it may be stripped up along the whole length of the shaft, and even detached from the epiphysis at each end. Should the child not die of toxæmia, extensive destruction of bone is certain to result.

When the epiphysis is attacked, the symptoms commence in the same way, but are likely to be followed by those of an acute suppurative arthritis (p 652). This affection is sometimes termed *acute epiphysitis*. It is almost limited to infants and very young children,



FIG 194 — NECROSIS FOLLOWING ACUTE OSTEO-MYELITIS (FROM SPECIMEN IN COLLEGE OF SURGEONS MUSEUM)

The irregular new bone of the involucrum is well seen, and within it portions of the sequester.



and is said to occur most frequently in the subjects of inherited syphilis. The head of the humerus and the upper and lower ends of the femur are the parts most commonly involved. In some of these cases the ligaments are so seriously weakened and relaxed that a loose flail-joint results.

In the milder types of osteo-myelitis, the patients complain of severe pain in one of the bones (one type of 'growing pain'), and this may be attended by some degree of fever and of local disability. The symptoms may quiet down after a time and no harm result, but in some cases the growth of the bone will be checked or entirely stopped. In other patients a subacute or chronic abscess may form and perhaps come to the surface at a later date, and on opening it a sinus is found leading to the interior of the bone, in which a sequestrum of cancellous tissue is found. In such a case the surrounding bone may at first be rarefied to such an extent as to bend under the weight of the body, but in the later stages is certain to be much thickened and very sclerosed.

The Prognosis of the acute form is always grave. Life may be threatened by pyæmia or toxæmia in the early stages, whilst later on hectic fever, amyloid disease, and exhaustion, may terminate the case if sepsis has been admitted.

The utility of the limb may be unimpaired if the disease has not been too extensive, and if prompt treatment has been adopted, but if life is threatened by toxæmia, or if neighbouring joints are suppurating, or if the osteogenetic powers of the periosteum have been destroyed by the acuteness of the process, amputation may be required. In cases which have recovered, excessive growth of the bones sometimes follows, owing to the long-standing hyperæmia of the part, but if the epiphyseal cartilage has been much affected the limb may be stunted in its subsequent development.

**Treatment** -- Prompt surgical interference must be adopted in order, if possible, to cut short the malady. As soon as the local pain and high fever give evidence that this affection is present, a free-incision should be made in the long axis of the limb through the periosteum, whether pus can be detected or not. The surgeon will then proceed to investigate carefully the condition of the bones by inspection and the use of the finger and probe. As a rule, he will find himself in the neighbourhood of the epiphyseal cartilage, and if the case has been taken in hand early, it is possible that the mischief will be quite limited, all that is then required is to scrape or gouge away the softened and hyperæmic bone at the end of the diaphysis, together with any necrotic tissue which may be present, taking the greatest care not to perforate the epiphyseal cartilage. The cavity thus formed is thoroughly washed with an antiseptic, a drain-tube or gauze packing is inserted, and in all probability recovery will rapidly ensue.

If the case has gone further, the periosteum will be found stripped from the bone for a varying distance, although but little pus may be found beneath it. Under these circumstances it is always necessary to open up by gouge, drill, or cutting-pliers the medullary canal, so

as to allow pus to escape and the hyperæmic and gangrenous fatty tissue contained therein to be scraped out. If this proceeding involves a considerable portion of the shaft, it may be possible to leave bridges of compact tissue here and there, scraping out the medullary cavity beneath them. When grave constitutional phenomena are present, associated with loosening of the epiphysis, it will often be found expedient to amputate in order to prevent death from toxæmia.

If the periosteum has been more extensively involved, a large amount of bone, possibly the whole diaphysis, is denuded, and perhaps both epiphyses are loosened. The dead diaphysis should be removed at once if the leg or fore-arm is involved, as there is always a second bone to maintain the length of the limb, but for the femur and humerus sequestrotomy should be delayed—immediate removal would lead to hopeless shortening and crippling of the limb. Some surgeons have recommended that a bone-graft or suitable rod of celluloid or ivory should be inserted to take the place of the resected diaphysis and stimulate the osteogenetic powers of the periosteum, there is no objection to such an attempt being made, provided that asepsis is maintained, but it is very questionable whether much good will follow.

When there is any doubt as to the actual condition of the bone, and the symptoms indicate that the medulla is not much involved, its immediate removal is undesirable, the pus is allowed to escape through a free incision, the cavity is well irrigated, and the stripped-up periosteum allowed to fall back upon the bone, and regain adhesions to it, if possible. Drainage is provided for, strict asepsis maintained, and the discharge soon becomes merely serous. A portion of the bone dies, and during its separation from neighbouring parts becomes incased in a newly-formed involucrum. When the sequestrum is free—that is, in about five or six weeks—sequestrotomy will be required, it consists in reflecting the periosteum from the new casing, and in enlarging or uniting one or more of the cloacæ, so as to allow the sequestrum to be withdrawn, it sometimes expedites matters to divide the sequestrum into two portions, and then to deal with each separately. The cavity thus left is well irrigated, and either drained or packed with gauze, so as to allow it to heal from the bottom by granulation. Occasionally the operation for removal of the sequestrum is exceedingly difficult and dangerous, owing to the situation of the sinuses, and in some places, *e.g.*, the posterior aspect of the lower end of the femur, it is almost impracticable to reach it, under such circumstances *amputation* may be preferable. This summary proceeding may also be needed in the course of this disease on account of pyæmia, defective repair, exhaustion from chronic sepsis, or suppuration in a neighbouring joint.

3 The Acute Septic Osteo-myelitis which arises as a result of infection from without, *e.g.*, in cases of compound fracture, and after amputation, excision, or even osteotomy, requires a separate description. The clinical history of a case involving the shaft of a long bone is as follows. The patient during an attack of septic traumatic

fever due to an injury or operation has one or more rigors, which suggest the existence of pyæmia, and is suddenly seized with severe pain in the limb, which becomes intensely sensitive. On examining



FIG 195 — TUBULAR OR CONICAL SEQUESTRUM FROM SEPTIC OSTEOMYELITIS AFTER AMPUTATION

the wound, the soft parts are found to be unhealthy and infiltrated, the lower end of the bone is bare and yellow, and from the interior a stinking mass of gangrenous medullary tissue sometimes protrudes. Should early and efficient treatment not be undertaken, the patient runs a considerable risk of succumbing to pyæmia or septic intoxication, whilst a varying amount of the interior of the bone dies (*central or tubular necrosis*), and a small segment of its whole thickness below, so that the sequestrum which ultimately separates is annular and conical (Fig 195). Should the patient survive, the necrotic tissue gradually separates, and during this process a mass of new bone is formed from the under surface of the periosteum, so that the shaft becomes much thickened externally. In the slighter cases a mass of granulations projects from the medullary cavity of the divided end of the bone, and in this there may be a newly-formed bony substratum.

**Treatment**—The wound is thoroughly opened up as early as possible, flushed out, and the sloughing medullary tissue scraped from the interior of the bone, which is subsequently disinfected with pure carbolic acid, a drain-tube or gauze wick being placed in it for a few days. A certain amount of necrosis follows, but without high fever or toxæmia. Should this treatment fail, amputation will be required.

A similar process may also invade the *short bones*, and the cancellous extremities of long bones, being often secondary to septic arthritis, or to a compound fracture involving such parts. The local and general phenomena are very similar to those detailed above, except that no large sequestra are formed, the dead bone coming away in small spicules (one form of *caries necrotica*), whilst the pain and fever are less severe, and there is less likelihood of the development of pyæmia. **Treatment** consists in free drainage, removal of the septic tissue, and efficient purification of the wound.

#### TYPHOID OSTEITIS

Affections of the osseous system are not uncommon in typhoid fever, and usually come on about the third week or during the early stages of convalescence. The tibia and ribs are most often affected, and in a large percentage of cases typhoid bacilli, with or without pyogenic cocci, will be found. It is curious to note how long the organisms may be latent in the tissues before causing an abscess—in one case (Sultan's) for six years. The trouble commences either as a

periostitis or osteo-myelitis, subacute in character, often improving for a time, and then relapsing. It often develops an abscess, and then some amount of necrosis or crabs may follow, thus in a case recently operated on by one of us a considerable sequestrum was removed from the upper third of the femur, whilst in the opposite leg there had been an abscess in a similar position, but without death of bone. The abscess is subacute or chronic, and the affected bone may be curious rather than necrotic. On its first appearance the affected limb should be elevated and fomented, and frequently the more acute symptoms will yield, but the part often remains enlarged, swollen, and tender, and exacerbations of pain are not unlikely to occur from time to time, sooner or later leading up to the formation of an abscess. When suppuration has occurred, the parts must be freely incised, diseased bone removed, granulation tissue scraped away, and the parts disinfected with liquefied carbolic acid. The wounds are usually found to be extremely chronic and indolent, and may require scraping several times.

### CHRONIC INFLAMMATION OF BONE

**Chronic Osteo-periostitis**—By this disease is meant a chronic inflammatory condition of the bone, which results in overgrowth, thickening, and condensation.

**Varieties**—(a) It may arise as a *localized* chronic periostitis, traumatic, rheumatic, or syphilitic in origin, or due to the close proximity of a chronic ulcer; it is characterized by a formation of new bone beneath the periosteum, the so called *node* (Fig 196). The cancelli are arranged at right angles to the surface, in consequence of the new tissue forming around the small vessels, which enter the bone from the under surface of the periosteum. At first this new material is soft and spongy, but it rapidly becomes hard and sclerosed, and a similar condition affects the subjacent compact structure, which is thickened and indurated by a new formation around the Haversian canals. If the irritation persists, as in the case of a chronic ulcer, this condition may run on into the following variety.

(b) The *diffuse* form of chronic osteo periostitis usually originates in some deep-seated or central affection, tuberculous or syphilitic in nature, and tends to involve the whole bone, although it is sometimes limited to one or other end. If tuberculous, there may be a small abscess or some central necrosis, and around this focus of prolonged irritation the bone becomes thick and indurated. In the later stages a considerable new formation may occur beneath the periosteum, and the medullary canal become entirely obliterated. If syphilitic in origin, it may

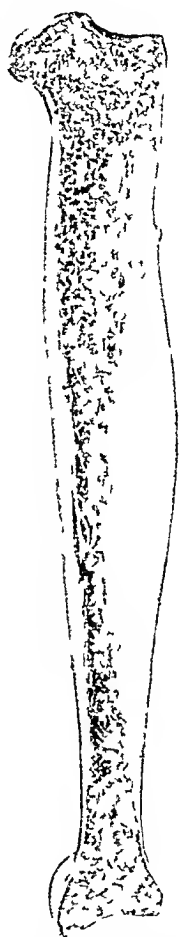


FIG 196—CHRONIC OSTEO-PERIOSTITIS OF TIBIA, SHOWING THE FUSIFORM SWELLING ON THE FRONT OF THE BONE CONSISTING OF DENSE OSSIFEROUS TISSUE AND THE MEDULLARY CAVITY ENCLOSED UPON (MUSEUM OF ROYAL COLLEGE OF SURGEONS)

be due to a central gumma, or a general condition of sclerosis may supervene without any localized focus

The **Symptoms** consist of deep aching pain in the limb, worse in bed, with perhaps tenderness over some particular spot. This latter condition is especially evident in cases where an encysted abscess exists in the head of a bone, such as the tibia. On examination the bone is felt to be thickened, and its surface more or less nodulated. If the disease is limited and superficial, a distinct node may be felt, consisting of a hard, fusiform, and tender swelling. Where the enlargement is more general, there is less tenderness, though the pain is constant.

The **Diagnosis** of such cases is not always easy, the enlargement of the bone being sometimes mistaken for the *early stage of a malignant tumour*. The rate of growth will be of little assistance, since it is very variable, but a tumour may have more defined limits, and its tension is often not the same throughout. Skiagraphy is valuable in this direction, since in simple chronic periostitis the bone is solid and throws a continuous and well-defined shadow, while in malignant disease a certain amount of soft tissue is sure to be present, either centrally or peripherally, easily penetrated by the rays, and hence leaving gaps in the shadow. If, in spite of such assistance, the case is still doubtful, an exploratory incision will be required.

The **Treatment** at first consists in resting the limb, applying counter-irritation (*e.g.*, iodine paint or the actual cautery), and giving iodide of potassium internally. If relief is not thereby obtained, an *operation* will be necessary. An incision is made over the whole length of the thickened bone through the periosteum, which is stripped aside, and if merely a nodular enlargement is present, the new formation is chiselled away. When the whole thickness of the bone is involved, a gutter or trench must be made by gouge and mallet, extending into the medullary cavity, and its length corresponding to the enlargement. The soft parts are then loosely drawn together and the wound dressed, the hollow will fill with blood-clot, and this is allowed to organize (p. 251). If enough bone has been removed, most satisfactory results follow, but in some aggravated conditions which have lasted for many years amputation is required.

### Tuberculous Diseases of Bone

Bone may be affected in two ways by tubercle, either the periosteum or the cancellous tissue being primarily involved.

1. In **Tuberculous Periostitis** a specific infiltration of the periosteum is met with, consisting of a deposit, partly in that membrane and partly under it, of pulpy granulation tissue containing the characteristic miliary tubercles, which are chiefly developed around the vessels passing from the periosteum into the bone. As in tuberculous disease elsewhere, caseation and suppuration are likely to follow, leading to the formation of abscesses, which are primarily subperiosteal and filled with curdy pus, these in time find their way

to the surface, either directly or by more or less tortuous channels, and leave sinuses, extending down to the bone. The final effect of such a condition depends largely on whether the subjacent bone consists of thick or thin compact tissue. If the compact bone is *thick*, the disease is usually localized to the part first affected, the surface of the bone escaping entirely, except some slight superficial erosion. Occasionally, however, the disease may spread along the periosteum, and involve a neighbouring epiphysis or joint. If the compact bone is *thin*, as in the bodies of the vertebræ, the underlying cancellous tissue is almost certain to be secondarily affected.

**Clinical History**—In the early stages a somewhat diffuse elastic or pulpy swelling forms over the bone, which is slightly tender on pressure. It takes some weeks or months to develop, and on skiagraphy the underlying osseous tissue may appear quite normal in texture. In the latter stages, when caseation or suppuration is present, the swelling often becomes more defined and its surface nodulated, it then somewhat resembles an ordinary node, but is usually more irregular in shape, of somewhat unequal consistency, and on firm pressure small portions may be felt to give way. If an abscess forms, the pain becomes greater, but it diminishes as soon as tension is relieved by discharge of the pus. The admission of sepsis, however, increases the trouble. It is probably seen in its most typical form in connection with the ribs or sternum.

**Treatment**—In the early stages, constitutional treatment may suffice, together with rest and carefully-adjusted pressure, as by strapping with Scott's dressing. The condition, however, demands incision if a neighbouring joint is threatened, or when suppuration has occurred. Free removal of all the granulation tissue and softened bone with a Volkmann's spoon is required, disinfection of the cavity with undiluted carbolic acid, and stuffing it with gauze soaked in a sterilized emulsion of glycerine and iodoform (10 per cent), the wound being allowed to granulate from the bottom. In dealing with the ribs, complete excision of the affected portion is advisable.

2 **Tuberculous Osteitis** always arises in cancellous tissue, and it affects the short bones, or the shafts or ends of long ones.

(a) The *short bones of the hands and feet* are very liable to this condition. It occurs in weakly children with a tuberculous inheritance, or in those whose general health has been depressed by one of the exanthemata, or sometimes in those otherwise healthy. Some slight injury may determine the onset of the attack, which frequently involves several bones simultaneously. When the phalanges are involved, the disease is known as **Tuberculous Dactylitis**.

**Clinical History**—The affected bone becomes slowly enlarged, expanded, and painful, the pain being, however, slight in amount, though sometimes worse at night. This continues for some time, until finally one spot rapidly increases in size, becoming red and tender, and finally an abscess forms, which bursts or is opened, leaving a sinus, down which a probe can be passed into the carious interior of the bone. Occasionally contiguous joints are involved in

this process, whilst the tendon sheaths are also liable to be affected, a large portion of the swelling is due to periosteal infiltration (Fig 197)

**Pathology**—A deposit of tubercle bacilli occurs in or around the bloodvessels in the interior of the bone, which may have been previously rendered somewhat hyperæmic as the result of an injury. The organisms produce their usual effect, viz, transformation of the normal medullary tissue into pulpy granulation tissue containing tubercles, the bony cancelli becoming meanwhile eroded and rarefied, and the bone corpuscles undergoing fatty degeneration (*vide* Caries, p 571). Sequestra occasionally form, but more often in adults than in children, owing to the greater density of the bone in the former. They are due to a cutting-off of the blood-supply of a definite portion of the bony tissue, either as a result of tuberculous endarteritis, or from early caseation within the cancelli of the whole of the granulation tissue. The sequestra are soft and friable, usually yellowish white in colour from the presence of the caseating tissue in their substance, and are seldom completely separated from the surrounding bone, thus, they are often quite clear superficially and laterally, but adherent on the deeper side. When the tuberculous disease does not involve the whole bone, the nearest healthy tissue may become sclerosed, and thus one not unfrequently finds a central sequestrum surrounded by rarefied bone which merges into an area of sclerosed tissue. When a tuberculous focus becomes septic, the destructive process increases in rapidity, and minute spiculated

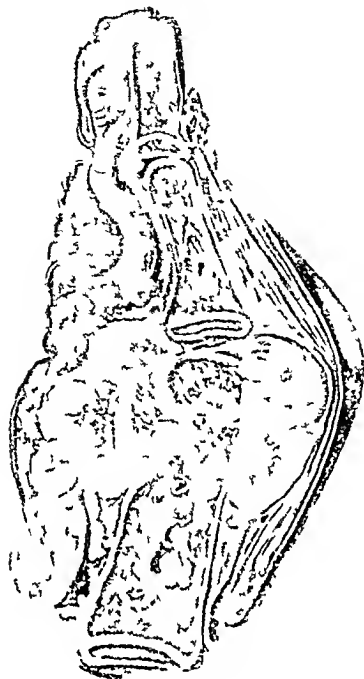


FIG 197 — TUBERCULOUS DACTYLITIS (ROYAL COLLEGE OF SURGEONS' MUSEUM)

This disease started in the proximal phalanx, and has perforated it anteriorly, the tuberculous material having involved the periosteum and tendon sheath, whilst the first interphalangeal joint is becoming invaded. There is also a considerable formation of granulation tissue on the dorsal aspect.

sequestra often come away in the discharge. The term *expansion* of bone used above is scarcely correct, inasmuch as the enlargement is due to absorption on the inner aspect, whilst there is a new formation of bone under the periosteum. Skiagraphy is a useful adjunct in estimating the amount of disease present, since the affected bone is less dense, and consequently light areas appear in the midst of the dark shadow cast by the bone (see Plate XXVI).

The **Treatment** of tuberculous dactylitis in the early stages con-



TUBERCULOUS DISEASE OF RADIUS

The patient was a lady over fifty years of age who had suffered for some months from pain and swelling of this bone. The site and extent of the disease is indicated by the light area in the shadow of the bone. Eventually amputation was required.





sists in attention to the general health, together with rest locally, and perhaps strapping the parts with Scott's dressing. Should the disease progress in spite of such measures, operation must not be unduly delayed, since neighbouring joints and tendon sheaths are very likely to be attacked. An incision is made down to the bone at some suitable spot where tendons or other important structures will not be injured, the periosteum is divided, and the outer layer of compact bone removed by gouge or trephine, so as to allow the diseased medulla to be scraped away with a Volkmann's spoon. When all the tuberculous tissue has been eliminated, the cavity thus produced is swabbed out with liquefied carbolic acid, any excess being washed away with absolute alcohol, the wound is then stuffed with gauze soaked in iodoform emulsion, in order to ensure healing by granulation. Unless this scraping is thorough, recurrence is very likely to ensue, but the integrity of epiphyses and of articular cartilages must be respected. When an abscess or a sinus exists, the same measures must also be adopted. Not unfrequently the growth of the bone is very considerably hindered, either by the disease or by the treatment requisite in order to eradicate it, and the part becomes stunted or deformed in consequence.

(b) Any of the *bones of the tarsus* may be involved in exactly the same manner, the clinical history and treatment being identical, although possibly articular lesions are somewhat more common than when the disease is limited to the phalanges. The affected portion of the foot becomes swollen, shiny, and pulpy, since the overlying periosteum is often involved in the process, and it is sometimes difficult to determine whether the lesion is limited to the bones or also involves the joints. In the early stages one part of the foot may be more swollen than another, according to the location of the trouble. The os calcis is most often affected, and afterwards, in order of frequency, come the first metatarsal, astragalus (the head), and scaphoid. When it starts in the astragalus, the swelling occurs below the level of the ankle-joint in front of or behind the malleoli, whilst pressure over the head of the bone gives rise to pain. The foot is usually in a position of equinus, but not to such a marked degree as when the ankle-joint itself is affected, the subastragaloid movements (inversion and eversion, abduction and adduction) are also considerably limited, or may be absent. An examination of the accompanying illustration (Fig 198) will explain the fact that tuberculous disease starting in the astragalus is very likely to involve the ankle-joint, or to spread to the os calcis or scaphoid. Disease of the os calcis leads to more limited swelling of the back of the foot on one or both sides of the heel, the movements of the ankle will not be impaired, although walking is painful, and hence the patient limps, treading only on the toes. Further forwards tuberculous disease is most likely to start in or around the scaphoid, the bulbous swelling of the foot being then shifted anteriorly, and the movements of the ankle remaining unimpaired. The prognosis is much worse when the disease attacks the inner half of the foot, comprising the astra-

galus, scaphoid, cuneiform, and three inner metatarsal bones, owing to the arrangement of the synovial membranes, than when it affects the outer segment, consisting of the cuboid and two outer metatarsals, which are excluded from the general synovial membrane, and are thus more amenable to treatment

Sooner or later suppuration occurs, with increased pain, and, should the sinus which results from opening the abscess become septic, the trouble is sure to spread much more rapidly, and the prognosis becomes increasingly grave

**Treatment** is conducted according to the rules which always guide us in that of tuberculous disease. In the early stages the foot and ankle are immobilized, and preferably in plaster of Paris or water-glass. The child is sent to the seaside, and plenty of good food administered, and it is not allowed to walk until all pain has ceased, even then the plaster case must be retained until the swelling has

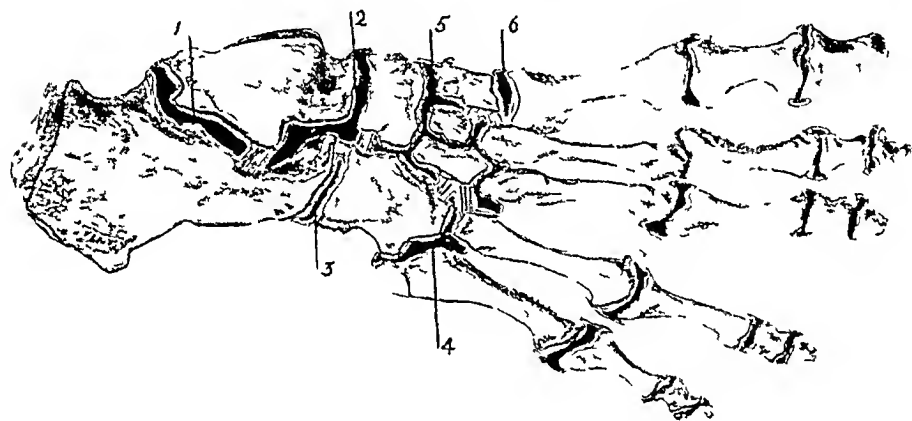


FIG 198—ARRANGEMENT OF SYNOVIAL MEMBRANES OF FOOT

- 1, Posterior calcaneo-astragloid, behind the interosseous ligament, 2, anterior calcaneo-astragloid and astragalo-scaphoid, 3, calcaneo-cuboid, 4, cubo-metatarsal, 5, the large common sac between scaphoid and cuneiform, between the cuneiform, and between the cuneiform and second and third metatarsals, 6, between the internal cuneiform and first metatarsal

entirely disappeared. It is wise to remove the plaster every month or two for inspection and re-adjustment

Should the disease persist in spite of such treatment, or should suppuration occur, removal of the tuberculous tissue by operation may be required. If the *os calcis* alone is involved, it will usually suffice to open well into it either from one or both sides, to scrape out its interior, and then pack it with iodoform and gauze after disinfecting it with liquefied carbolic acid. Decalcified bone chips mixed with iodoform have been packed into the cavity in order to hasten bony consolidation, but not with much success, in any case the interior of the bone becomes occupied by fibrous tissue, with perhaps a few bony spicules, and a marked permanent depression always remains at the site of operation. Excision of the *os calcis* was

formerly practised, but is not to be recommended, since even if performed subperiosteally, the power of repair that remains is very slight. If the disease mainly affects the *astragalus*, it may suffice to remove it entirely, neighbouring articulations being curetted, if need be, but probably the disease will have spread so far that amputation will be required, and then Syme's operation is better than methods, such as Pirogoff's, which retain any portion of the tarsus. Disease of the *cuboid* and outer half of the foot in front of the os calcis can often be dealt with efficiently by scraping, but when the common synovial membrane on the *inner side* is involved, amputation will probably be required, failing success by conservative measures.

(c) If the tuberculous disease affects *the ends of long bones*, it most commonly starts in the epiphysis, or under the articular cartilage, though sometimes on the shaft side of the epiphyseal cartilage. The changes already described take place, and lead to early destruction of the latter cartilage, so that the adjacent parts of both epiphysis and diaphysis become involved (tuberculous epiphysitis). The general signs are similar to those present when the smaller bones are affected, but the results produced may vary considerably. (i) In the slighter forms, where efficient treatment is adopted, the tuberculous tissue may be totally absorbed, and the process thus comes to an end, though the affection of the epiphyseal cartilage may lead to subsequent impairment of growth. (ii) In others it may be circumscribed by the bone becoming sclerosed around a caseating focus, and then, if suppuration ensues, a *deep abscess in the end of the bone* may be produced (Fig 199). Such is rarely of large size, containing at most 1 or 2 drachms of curdy pus, and is lined by a definite pyogenic membrane of the usual tuberculous type. The effects produced by this condition are similar to those of chronic osteo-periostitis, viz., a deep aching or boring pain in the bone, worse at night, together with enlargement of the affected part, whilst one spot is often very tender on palpation. If it has existed for any length of time, the whole shaft may become enlarged as a result of chronic osteo-periostitis (p 584). (iii) The disease may burrow along the epiphyseal line, and find its way into the neighbouring joint, if the epiphysis is intra-articular, as in the hip, but if the epiphyseal cartilage is placed beyond the limits of the capsule, a subperiosteal extra-articular abscess will develop (Fig 200). Should the disease spread equally in all directions, the epiphysis may actually be separated. (iv) A more common result is for the whole or part of the cancellous tissue of the epiphysis to become involved, and the joint to be secondarily affected with tuberculous arthritis, either by perforation, erosion, or necrosis of the articular cartilage, or by extension to the synovial membrane around its margins. (v) The process may sometimes extend upwards along the medulla into the shaft, causing a diffuse osteo-periostitis, with or without a medullary abscess (Fig 201).

The **Treatment** of tuberculous epiphysitis is conducted in the first place by absolute immobilization and hygienic measures, but the surgeon must not be tempted to trust too long to such a régime, for

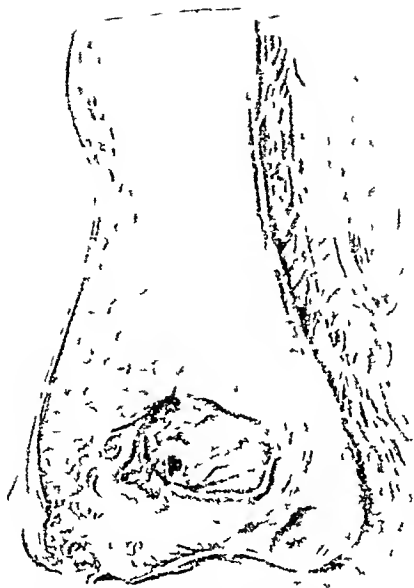


FIG 199 —CHRONIC ABSCESS IN THE LOWER END OF THE TIBIA (KING'S COLLEGE HOSPITAL MUSEUM )

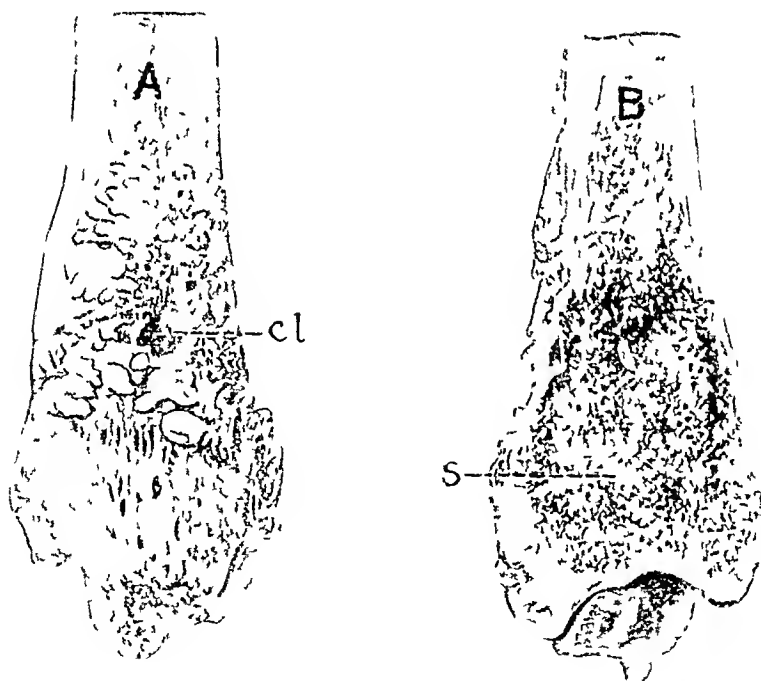


FIG 200 —LOWER END OF TIBIA AFFECTED WITH TUBERCULOUS DISEASE (KING'S COLLEGE HOSPITAL MUSEUM )

In A, a subperiosteal deposit of new bone is seen surrounding an opening (cl), which leads into the interior of the bone , in B, the interior of the same bone is seen, and shows a sequestrum (S) just above the epiphyseal line The ankle-joint is healthy

fear of the joint becoming also affected. If considered necessary, an opening is made into the interior of the epiphysis, and all the pulpy granulation tissue, caseous débris, or diseased bone removed with a sharp spoon, the cavity being subsequently disinfected, and stuffed with gauze infiltrated with iodoform. Of course, the utmost care must be taken not to open the joint by scraping through the articular cartilage. Where a chronic abscess exists in the end of a bone, a trephine should be applied over the tender spot, and, if the



FIG. 201.—LOCALIZED ABSCESS IN THE LOWER END OF THE FEMUR EXTENDING FROM THE EPIPHYSEAL LINE UPWARDS INTO THE MEDULLA (FROM SPECIMEN IN THE COLLEGE OF SURGEONS MUSEUM)

cavity is not at first opened, the bone may be drilled in different directions to ascertain whether or not pus exists.

(d) The *medullary canal* of the shaft of a long bone sometimes becomes the seat of tuberculous disease, this, as also the abscess of bone described above, is more common in adults than in children. The part thus affected becomes carious, with or without the formation of sequestra or pus, but the most marked feature of this deep-seated central trouble is that the whole bone passes into a state of chronic inflammation, which we have described, as well as the treat-

ment necessary for it, under the title of chronic diffuse osteo periostitis (p 584)

### Syphilitic Diseases of Bone

The osseous tissues may be involved in acquired syphilis in either the secondary or the tertiary periods

In the **Secondary Stage** flying pains about the bones (sometimes termed *osteocopic*) are often complained of, they are, however, of but little importance, and disappear rapidly as the patient gets under the influence of mercury. In the late secondary or early tertiary periods, a *periosteal node* is often met with, as a result of chronic periostitis. It usually affects only one bone, and most commonly the tibia, and consists of an infiltration and thickening of the periosteum, which may entirely disappear, but later on is accompanied by a formation of new bone. This is at first spongy and soft in character, but after a while becomes hard and sclerosed, the Haversian canals are always placed at right angles to the subjacent osseous tissues. When such has once occurred, absorption of the newly-formed bone does not readily follow, even under treatment, the part perhaps remaining permanently thickened. It is recognised clinically as a fusiform swelling, a little tender on pressure, and the seat of deep aching pain, usually worse at night. It must be understood that the pain is not so much associated with the onset of night as with the increased warmth of the limbs when in bed, indeed, patients with syphilitic tibiæ frequently sleep with their legs exposed. Night-watchmen and others, on the contrary, complain of pain during the day, when they take their rest. Suppuration does not often occur, and constitutional rather than local treatment is required.

In the **Tertiary Period** the bones may participate in the changes which involve any and every tissue of the body. These consist in an infiltration and overgrowth of the connective tissues, which if diffused through an organ produce sclerosis, if localized to one spot lead to the formation of a gumma. Hence the following lesions are met with

(a) The formation of *subperiosteal gummata*, either localized or diffuse, probably resulting in *caries* of the subjacent bone, if the affection is limited, only a small portion may be thus involved, but where it is widely diffused, an extensive surface of the bone may become eroded and irregular. This process is sometimes accompanied by a development of new bone under the adjacent periosteum, and is very often complicated by sclerosis and necrosis. The calvarium is the part most frequently involved in this change, but, owing to the osteogenetic powers of the pericranium being small, there is rarely any new formation of bone in the neighbourhood, and thus the skull may present a curious worm eaten appearance (Fig 202). Frequently the gummata break down and destroy the superficial scalp tissues, leaving deep and extensive wounds, discharging an abundance of foul pus, at the bottom of which bare and even dead bone may be felt.

(b) At the same time a condition of *sclerosis* may be produced in the underlying or surrounding parts, and this may progress to such a degree as seriously to compress and constrict the vessels in the Haversian canals. Moreover, an obliterative endarteritis is almost always present, and these factors, combined with the separation of the periosteum by the above-mentioned gummatous changes, so interfere with the vitality of the bone that, should sepsis occur in the broken-down gummata, necrosis is almost certain to ensue, especially in the skull.

The effects produced vary considerably in different cases, and especially with the situation. When the *calvarium* is attacked, septic phenomena are commonly present, and necrosis is a usual accompaniment of the gummatous changes. The process in such a case,



FIG 202 —SYPHILITIC CARIES OF SKULL FROM DIFFUSE GUMMATOUS DISEASE  
(FROM KING'S COLLEGE HOSPITAL MUSEUM)

as is represented in Fig 203, would probably be as follows. The pericranium corresponding to the necrotic area became gummatous, and at the same time the subjacent bone underwent sclerosis. Sooner or later the gummata burst or were opened, septic changes supervened, and the scalp tissues were stripped off the calvarium to the limits of the disease, necrosis resulting in the sclerosed area of bone. A line of rarefaction subsequently formed around the sequestrum in consequence of Nature's attempts to separate it. The disease is marked by its extreme chronicity, the sequestrum lying bare in the wound perhaps for years without being separated, owing to the slight degree of vascularity and the extreme condensation of the surrounding parts. Moreover, as explained above, there is an entire absence of an involucrum. In the *shafts of long bones*, where the compact tissue is thick and resistant, there may be extensive periosteal disease, with but little affection of the underlying parts, but if this compact layer is thin, and especially when the cancellous ends are involved, a considerable amount of destruction from caries may result, though if sepsis is not admitted there will be an entire absence of necrosis.

In the **Treatment** constitutional remedies, in the form of iodide of potassium and mercury, should, if possible, be depended on. Gum-



mata should never be opened without the strictest attention to asepsis. If sepsis has occurred, the wounds may be treated by applying iodoform and dressing with sterilized gauze steeped in lotio nigra, or covered with mercurial ointment. Counter-openings are often required for purposes of drainage, especially in the scalp. Necrosed portions, when separated, are to be removed, carious tissue may be scraped away with a sharp spoon, and the surface powdered with iodoform and dressed antiseptically. In the calvarium no attempt must be made to chisel away the dead bone.

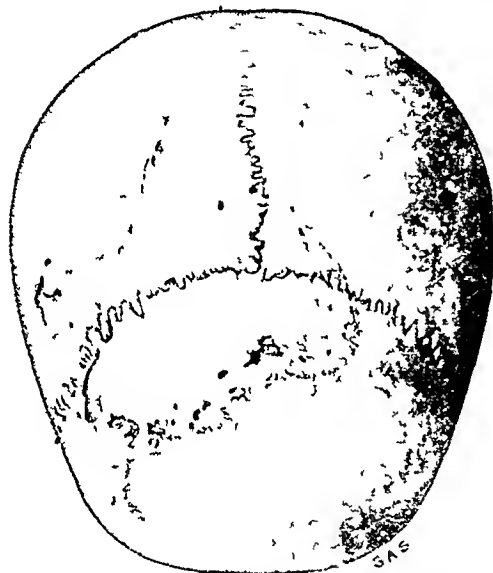


FIG 203.—SYPHILITIC NECROSIS OF THE SKULL (KING'S COLLEGE HOSPITAL MUSEUM)

The sequester is becoming separated, and a ring of caries is forming around it

to their nature. The greater rapidity of growth in the syphilitic cases, and the evidences of syphilis elsewhere, or of a syphilitic history, will often guide the surgeon to a right conclusion, but if there is any doubt an exploratory incision should always be made before amputation is undertaken.

In **Inherited Syphilis** any of the above manifestations may be seen, but with more or less special features added, and, in addition to these, certain forms which do not occur in the acquired type of the disease have been described.

1 A new formation of bone beneath the periosteum is perhaps the most frequent result, and this occurs with but little pain. Perhaps the most common situation of this lesion in infants is the calvarium, where bony masses known as *Parrot's nodes* form around the anterior fontanelle, causing the top of the skull to resemble a 'hot cross bun'.

(c) Occasionally a *gummatous osteomyelitis* is met with, in which a gumma forms in the interior of a bone. It results in the so-called expansion of bone and secondary thickening and enlargement of its whole structure, i.e., a diffuse osteo-periostitis. The symptoms are the same as those described for the latter affection, and if it resists the administration of anti-syphilitic remedies, it must be treated in the same way, viz., by separation of the periosteum, freely opening the medullary cavity, and removing all diseased tissue. These cases when affecting the long bones have often been mistaken for malignant growths, necessarily, it is a matter of the most vital importance to come to a right conclusion as

in shape In the early stages the bone is soft and spongy, and on post-mortem examination is dark red or maroon in colour If the process is not checked by suitable antisiphilic treatment, the newly-formed osseous tissue becomes dense and sclerosed, and the deformity may then persist through life (Fig 22, p 154) Any part of the calvarium may, however, be affected, and the change is not necessarily limited to the first years of life

2 A similar condition is met with in the shafts of long bones, due to the deposition of alternating lamellæ of soft and hard bone outside the ordinary compact tissue

3 *Syphilitic epiphysitis* (or, as it is termed, syphilitic *osteo-chondritis*) is a lesion characterized by enlargement of the ends of the bones, met with in infants, and somewhat resembling rickets, but coming on at an earlier date The enlargement is mainly situated in the epiphysis, but not uncommonly extends some way along the shaft, thus contrasting forcibly with rickets Occasionally only one side of the epiphysis is affected The change commences in the zone of calcified cartilage nearest the diaphysis, which becomes friable, opaque, and irregular, and as the condition progresses it may be transformed into granulation tissue, so that separation of the epiphysis follows This in turn sometimes results in suppuration and acute arthritis, or the limb hangs powerless in a condition known as *syphilitic pseudo-paralysis* The disease is usually symmetrical, and often multiple, and situated in much the same positions as rachitic affections, the knees, elbows, and wrists being perhaps most often affected

4 A symmetrical overgrowth of the tibiæ, perhaps combined with an anterior curvature, also occurs in syphilitic children, resulting in permanent elongation of the legs (p 442)

5 *Craniotabes* consists of a localized absorption of the osseous tissue of the cranium, leaving small areas where the bone is thinned or absent, so that on pressure a sensation of crackling, like that of parchment, is imparted to the finger It occurs most frequently in the parietal bone (in 60 per cent alone, in 95 per cent with other bones—*Carpenter*\*), and in the majority of cases within the first six months of life, a fact that throws considerable doubt on the idea that it is due to rickets

The **Treatment** of syphilitic lesions in children must be carried out in accordance with general principles, and mainly by the administration of suitable drugs

### Rickets

Rickets is a general disease of malnutrition, occurring in children, and manifesting itself mainly in lesions connected with the bones It usually commences within the first three years of life, but some times appears later

**Causes**—Any and every fault in the hygienic and dietetic treatment of a child seems capable of inducing rickets, but the most

\* *Carpenter*, 'Syphilis of Children in Every-day Practice' Baillière, Tindall and Cox 1901

important factor in its ætiology is insufficient or improper food, especially the too early administration of starchy materials, whilst uncleanliness and want of air and light also predispose to it. Prolonged lactation is not necessarily a cause, if the mother is healthy and capable of feeding the child, but amongst poor patients this habit is frequently responsible for its appearance, although in Japan, where the children are suckled for two or three years, the disease is unknown. Rickets is common in the poorer classes, who are herded together in small and badly-ventilated rooms, and is so peculiarly frequent in this country as to be known in Germany as the 'English disease' (*Englische Krankheit*).

The **Symptoms** may be divided into the early or general, and the later or osseous. The *general* symptoms are mainly referable to a state of irritability of the gastro-intestinal mucous membrane. The child may be fat and flabby, or thin and emaciated, the mucous membranes are pale, and vomiting and diarrhœa are constantly present, the motions being often green, slimy, and very offensive. The spleen is enlarged, the abdomen tumid, and profuse sweating of the head is very characteristic.

The commencement of the *osseous changes* is usually indicated by increasing irritability and restlessness, the child tossing off his bed-clothes at night, and crying out when handled or touched. The articular ends of the long bones become enlarged, as also the junction of the costal cartilages with the ribs. Sooner or later the shafts of the long bones soften, and may bend in various directions, and thus many *deformities* may be produced.

The *head* usually becomes flattened antero-posteriorly, so that the forehead appears square in shape and enlarged, whilst frontal bosses may develop on either side, due to new formation of bone under the periosteum, it is a question, however, whether these are not syphilitic rather than rachitic in origin. The fontanelles remain open much longer than usual, and craniotabes is said to occur. The teeth do not erupt till late, and are stunted, defective in enamel, and easily eroded, so that the ends of the incisors are often concave, they must not be mistaken for syphilitic teeth, since the concavity is a small arc of a large circle, whilst the typical notch of syphilis is a large segment of a small circle.

The *spine* may be affected by kyphosis (p 428), or less frequently by scoliosis (p 423), the kyphotic curve results when the patient is allowed to lie too much in bed with the head on a high pillow, or if it is carried about with a curved back, scoliosis more often occurs when the patient is able to walk. Occasionally the two conditions are associated in the same child, a kypho scoliosis resulting, which is usually due to its being carried about sitting on a nurse's arm with the pelvis tilted.

Changes in the *thorax* are produced by enlargement of the costochondral junctions (*beaded ribs*), which, when present on either side of the sternum, produce what is known as the *rickety rosary*. If there is any obstruction to the entrance of air into the lungs, as from

tracheitis or bronchitis, the atmospheric pressure may cause the softened bone and cartilage to sink inwards, and as a result of this the sternum may be pushed forwards (*pigeon breast*), whilst the curvature of the ribs at the angle is increased. A very characteristic feature of the rickety change consists in the lateral groove thus produced on each side of the sternum, which may meet with a transverse depression below, caused by the projection of the lower ribs by the tumid abdomen.

The *pelvis* is flattened antero-posteriorly, or more rarely triradiate, the former condition being produced when the patient lies habitually on his back, the latter only occurring when he is allowed to walk about, the acetabula being thus pressed inwards and backwards by the heads of the femora.

The deformity of the *long bones* (Fig 204) usually consists in an increase in their natural curves, especially at points where powerful muscles are attached. The femora are curved antero-posteriorly, and the tibiae in a similar direction, although there is often some lateral displacement superadded. Most commonly the lower end of the tibia is bent inwards—*ie*, in a direction opposite to that represented in Fig 204. Genu valgum or varum may also result from the epiphyseal changes.

When the acute stage of rickets has passed away, any deformities present become fixed by the complete ossification of the softened bony tissues. As a rule, the density of such deformed bones is increased, whilst their natural shape is altered by deposits of new subperiosteal bone or struts in the concavities, so that on section they are usually more or less flattened from side to side. Growth is often checked by this disease, so that the individual becomes stunted and dwarf like.

Pathologically, the chief changes in rickets are found in the neighbourhood of the epiphyses. Ordinarily, the epiphyseal cartilage is a lamella about a line in thickness, bounded on either side by a zone of calcified tissue, containing regular alveolar spaces filled with

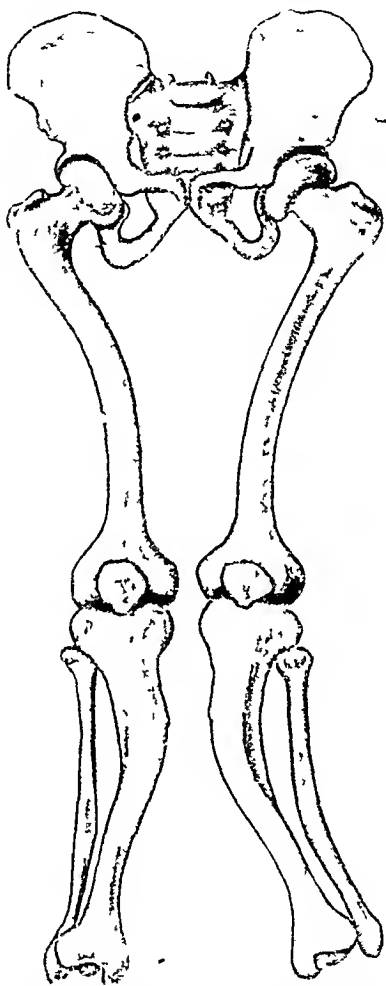


FIG 204 — PELVIS AND LEG BONES IN RICKETS (FROM COLLEGE OF SURGEONS MUSEUM)

vascular medulla, and lined by osteoblasts, shelving gradually into normal cancellous bone. In rickets the epiphyseal cartilage is not only circumferentially enlarged, but also thickened and irregular (Fig 205), outgrowths of cartilage projecting on either side into the calcified tissue, which is more abundant and more open in texture than usual, whilst it passes irregularly into the cancellous bone. Thus, there is an increase in the material which Nature prepares for the formation of bone, but the ossifying process is inefficiently carried out. In addition to this, the Haversian canal systems and the medullary spaces in the diaphyses are enlarged, so that the bones



FIG 205 — SECTION THROUGH LOWER END OF RICKETY RADIUS, SHOWING ENLARGED DEPTH AND IRREGULAR BORDERS OF THE PROLIFERATING EPIPHYSEAL CARTILAGE



FIG 206 — TRANSVERSE SECTION THROUGH THE SHAFT OF THE ULNA FROM A RICKETY CHILD OF THIRTEEN MONTHS ( $\times 10$ ) SHOWING SPONGY TISSUE BENEATH THE PERIOSTEUM INSTEAD OF THE COMPACT TISSUE OF NORMAL BONE

(From Ashby and Wright's 'Diseases of Children')

become weaker and less rigid from the insufficient amount of lime salts present, and thus readily bend under the weight of the body or from muscular action. Less frequently the subperiosteal compact bone becomes similarly rarefied (Fig 206). When the disease comes to an end the deformities may persist, and the bone become harder and stronger than usual, the medullary canal being often narrowed in the long bones, and displaced towards the convex side of the curve.

In the **Treatment** of rickets the most essential feature in the early stages is the correction of all errors in the personal hygiene. The diet should consist of good cow's milk, diluted if need be, and with lime-water added, whilst the juice expressed from raw beef, or one of the many meat juices now sold, may also be administered. The condition of the bowels must be attended to, and the child placed in as good surroundings as possible. Parrish's food (syr ferri phospho) may be given by itself, but if the infant is thin and emaciated, cod-liver oil should be added. Deformities must, if possible, be prevented by keeping the child in the recumbent posture, and not allowing it to crawl or run about. The early stages of deformity in young children can often be corrected by daily manipulation of the affected bones, for the legs, it may suffice to keep them off their feet, as by a splint which extends from the thighs 6 inches below the soles, a certain amount of pressure can also be exercised by this appliance. Osteotomy, or even resection of portions of bone, is required in the severer cases where the deformity persists (see p 442).

**Infantile Scurvy (Syn Barlow's Disease, Scurvy Rickets, Hæmorrhagic Rickets)**  
—This condition, first accurately described by Sir Thomas Barlow, presents the symptoms of scurvy in a rachitic child, and in its manifestations either one or the other set of phenomena may predominate. It is usually seen in the children of well-to-do people, usually from four to eighteen months old, and apparently arises from defective nutrition, especially from the prolonged administration of peptonized or prepared foods, or even possibly of sterilized milk. In the slighter cases there may be but little evidence of the scorbutic condition, beyond the fact that in a rickety child there is some tendency for the gums to bleed, or a little hæmaturia, but in those that are more marked the rickety signs are of little importance compared with those due to hæmorrhagic extravasations. The disease often comes on suddenly with some amount of pyrexia, rarely exceeding 102° F, but the child is evidently ill, and perhaps complains of tenderness of the limbs, which may be kept so quiet as to suggest that they are paralyzed. This is followed by the appearance of swellings of some size, due to subperiosteal extravasations, the skin over the affected parts being at first shiny and œdematous, but subsequently becoming stained by the blood-pigment. The femur and tibia are most often affected in this way, and the epiphyses may occasionally become detached, or even spontaneous fractures occur. Bleeding may also take place beneath the conjunctiva or into the orbit, leading to protrusion of the eyeball, whilst there may be blood stained diarrhœa, hæmaturia, or epistaxis. The disease, when recognised, is readily amenable to *treatment*, but should its nature be overlooked, the child is likely to become emaciated and die. Attention to the diet is the main point to be attended to, for when fresh milk, lime-juice, or vegetables are given, the symptoms soon disappear. The affected limbs must be kept at rest, and cooling lotions applied, whilst splints are employed for separated epiphyses or fractures.

**Achondroplasia** is the name given to a rare and curious congenital condition, somewhat resembling rickets, in which the growth of osseous tissue on the shaft side of the epiphyses of the long bones of both arms and legs is defective, so that the limbs are short and stunted, and the stature correspondingly diminished, although the epiphyses are normal. The bones generally are not bent or curved abnormally, though there is probably some change of the neck or shaft of the femur, resulting in lordosis, which is very marked when the patient stands. The fingers taper to their tips, and are separated one from another in 'spoke-like' fashion. The bones at the base of the skull, being of cartilaginous origin, undergo premature synostosis, whilst the upper half of the skull, being derived from membrane, and therefore developing naturally, looks unusually large, the face

is small, and the bridge of the nose depressed as in congenital syphilis. The children, if they live, are usually efficient in their mental development, and the thyroid body normal. No known treatment is of any value.

### Simple Atrophy of Bone

This results from a variety of conditions quite independent of racking inflammation, in which it is always a marked feature. (a) It may be *congenital*, perhaps involving bones and soft tissues alike. (b) It may result from interference with the epiphyses, as in rickets, or after injuries, or as a sequela to tuberculous or other inflammations involving the junction cartilage. (c) It may be due to injury or disease of the central nervous system or of peripheral nerves, as in tabes dorsalis, syringomyelia, leprosy, etc. (d) It may be caused by want of use, as in a paralyzed or ankylosed limb. (e) Local pressure, as of a tumour growing within or outside the bone, or of an aneurism, may determine its existence, and possibly to such a degree as to result in spontaneous fracture. (f) It may be a senile change, as seen in the lower jaw, cervical femora, or cranium.

The type of atrophy varies with the cause. Sometimes it merely consists in arrest of longitudinal development, at others the bones are not only short, but smaller in all directions, and in leprosy may undergo almost total absorption. If the cause is localized, and acts from without, the compact bone is more or less cleanly eroded, whilst if the cause is general, absorption may occur either from within, the medullary canal becoming enlarged and the compact tissue thinned, or from without, the cross-section of the bone gradually dwindling.

The possible presence of atrophy must always be kept in mind when dealing with ankylosed or paralyzed limbs, since very little force may suffice to produce a fracture.

### Mollities Ossium (*Syn* Osteo-malacia)

This disease is one of somewhat unusual occurrence, characterized by the absorption of the osseous substance of the bones, as a result of which softening and rarefaction are produced, followed by bending or spontaneous fracture.

The complaint is almost limited to the female sex (only 8 per cent. of the cases reported are in males), and usually commences during pregnancy, it is said to be sometimes connected with a rheumatic tendency. Any part of the skeleton may be affected, in females the change usually attacks the pelvis, spinal column, and ribs first, and the limbs later; in men the process starts in the long bones.

**Pathologically**, the change consists in a replacement of the medullary substance by a soft fibro-cellular tissue, which is exceedingly vascular, and into which hemorrhage often occurs, the resulting material looks in the fresh state something like splenic pulp. The bony cancelli are absorbed, as also the greater part of the compact tissue, with the exception of a thin layer situated beneath the periosteum, in a well-marked case the mineral salts may be diminished to about one sixth of their normal amount, but the relative proportion of phosphate of lime to the carbonate is not changed. Part of the bone substance remains for a time in a decalcified state, with the corpuscles evident, but in a condition of fatty degeneration. Probably some acid—e.g., lactic acid—is the active agent in dissolving the earthy salts, which escape partly in the urine, partly in the feces. It is possible that the process is connected with the absorption of some internal secretion, normal or vitiated, particularly that from the ovary, an idea suggested by the fact that the removal of the uterine appendages has in a few cases stayed the disease.

**Clinically**, the onset is usually somewhat indefinite, the only complaint being of pain in various parts of the body, whilst the patient becomes emaciated and exhausted. Sooner or later skeletal changes ensue and demonstrate the character of the disease. The limbs may either bend or break, in the latter case there is often no attempt at repair. The pelvis becomes tumid in shape owing to the acetabula being pressed inwards and backwards by the weight of the body, and in pregnant women this may cause so much deformity as to necessitate Cæsarian section or Pott's operation. Death may result from exhaustion, or from obstructed

tion to parturition, or the patient may live more or less bedridden for years, the limbs becoming useless, shortened, and perhaps contorted in a strange and abnormal fashion

**Treatment** is unsatisfactory. Opiates may be administered to relieve pain, which is often very severe, and various drugs, such as alum, and phosphate or hypophosphate of lime, have been recommended. In cases not associated with parturition or pregnancy, oophorectomy is said to have been employed with benefit. The induction of premature labour is considered by some to be beneficial, not only for the sake of obviating the necessity for such operations as Cæsarian section, but also on the chance of checking the disease.

### Hypertrophy of Bone

It is always a matter of difficulty to draw a definite line between a true hypertrophy and inflammatory or other overgrowths, and especially is this the case in connection with bones where chronic inflammation is always associated with new bone formation. Two or three conditions to which the term hypertrophy is perhaps more correctly attached may, however, be mentioned. (a) It is sometimes congenital, if involving a whole limb or any large portion of the body,

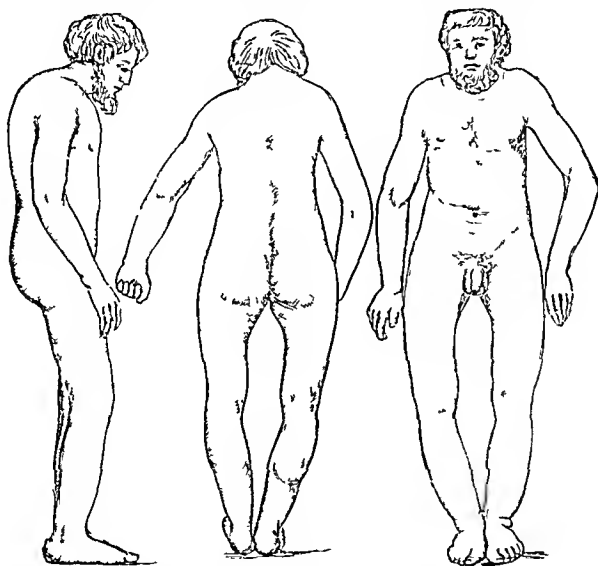


FIG 207 —OSTEITIS DEFORMANS (BRYANT)

it is known as *Gigantism* if merely affecting the fingers and toes, it is termed *macrodactyly* (p 431). (b) It may follow inflammatory affections of bones, which are thereby left with an increased blood-supply, e.g., after acute osteomyelitis, which has not destroyed the epiphyseal cartilages, in such cases the overgrowth is mainly longitudinal. (c) Increased growth of bones is associated with several diseases to be described immediately—viz., osteitis deformans, acromegaly, etc., and in these it is possibly due to the effect of some internal secretion.

### Osteitis Deformans

Osteitis deformans is an inflammatory disease of the osseous skeleton, first described by Sir James Paget in 1876. The onset is insidious, and the progress very slow. It is characterized by a painful overgrowth of the long bones, spine, cranium, and pelvis, which are also softened, so that those which bear the weight of the body become curved. It may commence in one bone alone, and then



usually the tibia or femur but more often many bones are affected at the same time. Attention may be drawn to the condition, either by the pain, which the patient at first considers to be rheumatic, or by the general enlargement and bending of the bones, or by the increased size of the head, necessitating the use of larger hats. The cranial overgrowth is eccentric in character, and the calvarium may become very thick, the facial skeleton, however, is not much affected. The spine becomes markedly kyphotic (Fig 207), the dorsal curve being increased, and the lumbar concavity obliterated, it is nearly rigid from ankylosis of the vertebrae, and may be very painful. The head is carried forwards by the bend of the spine, the height is diminished, the shoulders are round, and the chest sunken towards the pelvis, the gait is slow and awkward. The disease usually attacks middle-aged men, its progress is exceedingly slow, the patient often living to an advanced age, or dying from some intercurrent malady. Some cases have terminated in multiple sarcoma of the bones. The structure of the osseous tissue is suggestive of inflammatory rather than degenerative changes. It is softer and more uniform in structure than usual, the difference between the cancellous and compact tissue being less defined, the Haversian canals are large, and arranged irregularly, whilst the bony substance is chalky-looking.

**Differential Diagnosis**—From *arthritis deformans*, which it resembles by the attitude and gait of the patient, it is known by the absence of articular lesions, especially in the fingers, and the enlargement of the bones, notably of the cranium. From *acromegaly* it is distinguished by the absence of enlargement of the hands, feet, and lower jaw.

**Treatment** is most unsatisfactory, no remedy at present known having any control over the disease.

### Acromegaly

Acromegaly is a rare condition the characteristics of which were first described by Dr Pierre Marie in 1885. It is a general affection involving mainly the osseous system, commencing usually in young adults, and, after lasting for a long time, killing the patient by syncope or cerebral compression, if some intercurrent malady does not destroy him.

It is characterized by a very definite enlargement of the hands and feet, which are, however, not lengthened, so that the hands have been compared to battle-axes, and the fingers to sausages. The bones themselves are enlarged, and the soft structures on the palmar aspects project as pads. The nails and skin are unchanged, whilst the other segments, both of the upper and lower limbs, are usually unaffected, though sometimes considerable overgrowth in length occurs, in fact, many of the so-called giants who have been exhibited are typical illustrations of acromegaly. Both the upper and lower jaws are thickened and prominent, whilst the lower lip is enlarged and overhanging. The orbital ridges project, and the forehead is usually low, the nose and tip of the tongue are also more or less enlarged. The spine is kyphotic in the dorsal region, with a slight lumbar lordosis. The ribs and sternum project anteriorly.

The patient usually suffers from headache, lassitude, and great fatigue, wandering pains about the body, and excessive appetite and thirst, amenorrhoea is a marked symptom in women, whilst men suffer from a loss of virile power. The urine is abundant, but of a low specific gravity. Vision is usually diminished, and optic neuritis has been observed in some cases.

**Morbid Anatomy**—But little is known as to the cause or pathological changes occurring in this disease, beyond the fact that the anterior glandular half of the pituitary body is hypertrophied, and the sella turcica expanded. The changes in the bones are merely those of overgrowth.

**Diagnosis**—The disease has been mistaken for *myxodema*, but there is not much difficulty in distinguishing the two if it be remembered that, in the latter condition, the skin is not mobile over the thickened subcutaneous tissue, that the face is broad, pasty, and puffy, and that masses of gelatinous tissue are found above the clavicle, whilst in acromegaly the face is elongated and the skin and subcutaneous tissues normal. The mental condition and speech of a patient

suffering from myxœdema are widely different from those in acromegaly, whilst in the former the thyroid body is either absent or diseased, and in the latter skeletal changes are present. From *chronic osteo-arthritis* affecting the hands, the diagnosis is easy, in that there are usually no signs of articular disease, and much less pain. From *osteitis deformans*, the distinguishing features have already been indicated.

**Treatment** is merely symptomatic, antipyrene being useful in relieving the headache, as also valerianate of caffeine. Possibly thyroid extract may be of some use in combating the functional phenomena, though it will not influence the skeletal changes.

### Hypertrophic Osteo-arthropathy

It has long been known that clubbing of the terminal phalanges is associated with chronic pulmonary and cardiac disease, and it is probable that such is the earliest stage of this more generalized affection, first described by Pierre Marie. In it the



FIG. 208.—HEAD OF WOMAN WITH ACROMEGALY. SEEN FROM THE FRONT AND FROM THE SIDE †

ends of the fingers and toes are enlarged and bulbous, with the nails curved over towards the palm or sole, but radiography has demonstrated that the change is limited to the soft tissues. There is a considerable swelling of the bones just above the wrists and ankles, extending some way along the shafts, and similar bony enlargements sometimes occur elsewhere, they are due to a diffuse osteo-periostitis. The spine is kyphotic in the upper dorsal region, but with well-marked lordosis below. It is thus seen that the changes are somewhat like those of acromegaly, from which they are distinguished by (a) the implication only of the terminal phalanges, (b) the swellings above the wrists and ankles, and (c) the absence of the characteristic deformities in the skull and head. These phenomena probably result from a chronic osteitis, due to toxic absorption, since the condition arises in such diseases as chronic bronchitis, bronchiectasis, and chronic empyema, where suppuration has existed for some time. It is, however, sometimes associated with lesions other than pulmonary—e.g., chronic jaundice, syphilis, and even influenza, and has even been found in otherwise apparently healthy individuals. Little can be done in the way of treatment, except to deal with the cause, if obvious.

\* See Janeway, *Amer. Jour. of Med. Sci.* October 1903.

† Reproduced from the *Edinburgh Medical Journal*, by kind permission of Dr G. A. Gibson.

### Tumours of Bone

The characters of the osteomata, chondromata, and fibromata of bone have been described in Chapter VIII, and various solid and cystic tumours connected with the teeth are dealt with elsewhere.

**Sarcoma** is the most important primary tumour of bones, and almost any form may occur. The microscopical characters have been detailed in the chapter on tumours, and we shall here only refer to their *clinical characteristics*. They may be divided into two main groups—the endosteal or central, and the periosteal.

**Endosteal or Central Sarcoma** (Figs 209 and 210) of bone commences in the medullary cavity or cancellous tissue, and results in the so called 'expansion of bone,' which consists in absorption of the bone from within, whilst at the same time new osseous tissue is being deposited from the under side of the periosteum, though in these cases only to a limited degree. The **Symptoms** at first resemble those of chronic osteo-periostitis, although in most cases of tumour there is rather less pain. The growth usually commences near the end of a long bone, it seldom encroaches on the articular cartilage, so that the joint escapes, although it may contain an excess of serous fluid, occasionally, however, the growth may extend laterally beyond the level of the cartilage, and thus invade the articular cavity. Spontaneous fracture is not an unfrequent complication, and owing to the expansion of the bony framework, 'eggshell crackling' is sometimes met with. After a while, the growth may extend beyond the osseous limits into the soft parts, and then the chances of general dissemination are considerably increased.

Two chief varieties of endosteal sarcoma may be described. (1) *Myeloid* tumours (Fig 209) are almost benign in character, never giving rise to secondary deposits, either in lymphatic glands or viscera, and their growth within the bone is limited to the region from which they originated, sometimes a layer of condensed bone forms a definite barrier to check any advance along the medullary canal. The sites of election for myeloid tumours are the lower ends of the femur and radius, and the upper ends of the tibia and humerus—that is, where the growth of the limbs is greatest, they also grow within the horizontal ramus of the lower jaw and the diploe. Not uncommonly a fibro-sarcomatous epulis is myeloid in nature. They always lead to expansion of the bone, the tumour substance is soft and vascular, and they often contain cysts of hæmorrhagic origin.

(11) *Central round or spindle-celled sarcomata* are of a very different nature, being extremely malignant. Not unfrequently there is comparatively little expansion (Fig 210), but the growth diffuses itself along the medullary cavity, and early infects lymphatic glands or viscera. Should the outer wall of the bone be absorbed, the growth will extend into neighbouring soft tissues. Cartilaginous and myxomatous nodules are often associated with the sarcomatous tissue.

In considering the nature of an endosteal sarcoma, it should be remembered that myeloid tumours grow more slowly than the round-



FIG 209 —MYELOID SARCOMA OF HEAD OF TIBIA  
(KING'S COLLEGE HOSPITAL MUSEUM)

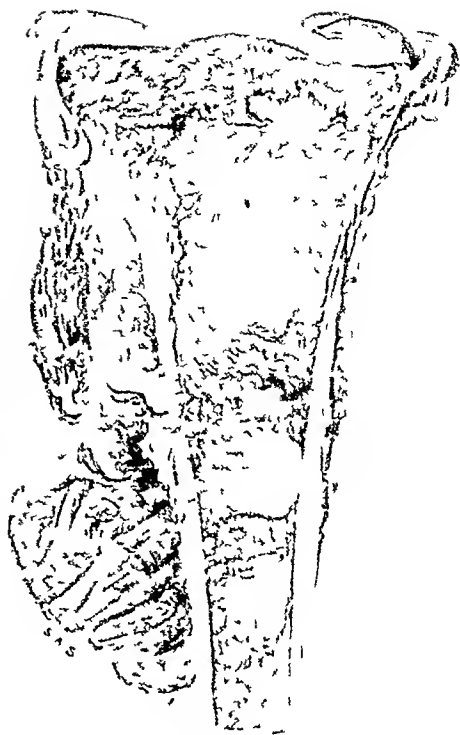


FIG 210 —ROUND CELLED ENDOSTEAL  
SARCOMA DISSEMINATING ITSELF IN  
THE MEDULLARY CAVITY (KING'S  
COLLEGE HOSPITAL MUSEUM)



FIG 211 —SOFT PERIOSTEAL SARCOMA  
OF LOWER END OF FEMUR ERODING  
BONE AND LEADING TO SPONTANEOUS  
FRACTURE (KING'S COLLEGE  
HOSPITAL MUSEUM)

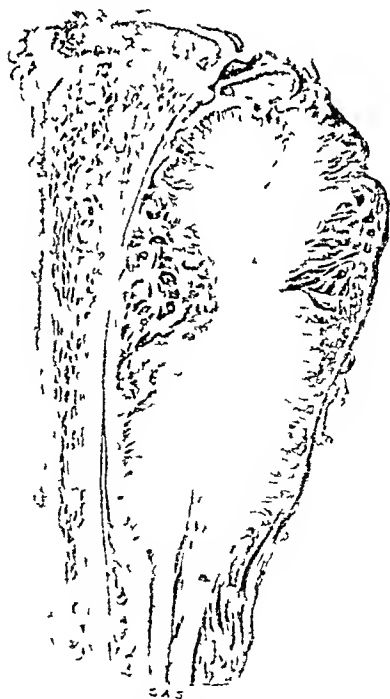


FIG 212 —OSSIFYING PERIOSTEAL  
SARCOMA OF FIBULA (KING'S  
COLLEGE HOSPITAL MUSEUM)

or spindle-celled, and are more likely to develop cysts, owing to hæmorrhage into their substance. In all of them a certain amount of bony skeleton may pervade the growth. Radiography may be of assistance by indicating whether the growth is localized or diffused through the medullary cavity.

The **Periosteal Sarcomata** are round- or spindle-celled in nature. They often grow very rapidly, without giving rise to much pain, unless causing erosion of the bone. They usually start on one side of the bone, but later on may surround its whole circumference. They spread rapidly along its exterior, and are highly malignant in nature, giving rise to secondary growths in the neighbouring lymphatic glands or in the viscera. They frequently become ossified (Fig 212), with or without the development of cartilage, and in such cases the subjacent bone becomes sclerosed and thick. The bony skeleton of such a growth is very characteristic, consisting of fine spiculated trabeculæ, radiating more or less regularly from the surface, and looking in the dried state somewhat like asbestos. When a periosteal sarcoma does not become ossified, the growth usually erodes the underlying bone (Fig 211), and may lead to spontaneous fracture, the tumour in such cases is softer and more elastic than in the former variety. All osseous sarcomata are exceedingly vascular, and may even pulsate, whilst the superficial veins are obviously dilated beneath the stretched integument, giving rise to a blue network.

The **Diagnosis** of osteo-sarcoma in the early stages is often a matter of the greatest difficulty. The endosteal form may easily be mistaken for chronic osteo-periostitis, medullary gumma, or a deep abscess of the bone, and can sometimes only be distinguished from them by an exploratory incision, which should always be undertaken in doubtful cases prior to radical operations, such as amputation. In the later stages, the presence of 'eggshell crackling' or cystic change will help to make evident the nature of the disease. The periosteal form may at first be looked upon as a periosteal node, or a deeply-placed abscess. The rounded and definite edge of the growth, its irregular consistency, and the history of the case, will assist in the determination of its nature, but in the early stages an exploratory operation is not unfrequently necessary. For the diagnosis of a pulsating sarcoma from an aneurism, see p 307. When either form involves the articular end of a bone, especially the lower end of the femur, it may simulate tuberculous disease of the adjacent bone. It will, however, be noted that the centre of the swelling corresponds to a point well above or below the joint, that a certain amount of movement is possible and even painless, whilst the starting pains at night characteristic of joint mischief are absent. The age of the patient, and the presence or not of cachexy, are also important features which have to be taken into consideration. Skiagraphy serves in some cases as an important diagnostic adjuvant.

The **Treatment** of osteo sarcoma must always be of a radical nature, and, remembering the highly malignant character of many of these growths, we would strongly urge the importance of an early explora-

tory operation in doubtful cases, if undertaken with antiseptic precautions no harm can ensue, and a definite diagnosis is thereby possible. If the case is left until increased growth reveals the true state of affairs, it is more than likely that, except in the myeloid variety, it will be too late for successful operative interference. In every form of the disease except the myeloid, the affected limb should be removed high above the tumour. Thus, if growing from the lower end of the tibia, disarticulation at the knee-joint should be performed, if at the upper end of the tibia, amputation through the middle or lower third of the thigh, if from the lower end of the femur, amputation through the upper third of the bone, if not at the hip-joint. For sarcoma of the head of the humerus, disarticulation through the shoulder-joint may suffice, but it is often wiser to remove the scapula and greater part of the clavicle as well (interscapulo-thoracic amputation). The results of the latter proceeding, as regards final cure, have been much more satisfactory than those of the former. When muscular bellies have been invaded, it is desirable, though not always practicable, to include the whole extent of them in the scope of the operation.

Myeloid sarcomata being practically non malignant, except locally, are dealt with in a much more conservative manner, amputation through healthy tissue just above the growth being all that is necessary. It is advisable that the medulla at the point of section of the bone should be examined microscopically before the wound is closed, to make certain that it has not been invaded. When affecting the lower end of the radius or upper end of the humerus, and not in too advanced a stage, an attempt may be made to save the limb by excising the diseased portion of bone. In the wrist a portion of the ulna is taken away, as well as the growth in the radius, by this plan there is less chance of the hand being drawn up and abducted, and hence it is more likely to become useful. A leather gauntlet to steady the part subsequently will almost certainly be required. Central sarcoma of the lower jaw, if myeloid in nature, may be treated by making a free opening in the bone, scraping the diseased tissue away, and swabbing out the cavity with pure carbolic acid. The continuity of the jaw may thus be maintained, even if the teeth are lost.

**Secondary Sarcoma** of bone is by no means uncommon. It is usually endosteal in character, and, except in the most unusual circumstances, will not demand treatment, owing to the general infection of the system. Possibly where it has led to spontaneous fracture, and there is much pain owing to the difficulty of fixation, it would be justifiable to remove the limb.

**Carcinoma** of bone is always secondary in nature, although it may be involved by direct extension in a primary growth. It may occasionally lead to spontaneous fracture, but the bone may consolidate again satisfactorily.

For the so called **Thyroid Cancer** of bone, see Chapter XXXI.

**Pulsating Tumours of Bone, or Osteo aneurism** — Apart from pulsating sarcoma, two other conditions are met with, the nature of which

cannot be considered as yet settled, in which distinct pulsation is also noticeable

In the first of these the medullary cavity is occupied by a non-malignant vascular tissue, practically identical with what we have already described as an *aneurism by anastomosis*. A large number of small arterioles open into spaces without the intervention of capillaries, so that an erectile tissue similar in nature to the corpus cavernosum penis results. Such tumours are situated most frequently in the cranial bones, and may be multiple, the medullary tissue being in consequence atrophied, and the compact tissue thinned, so that 'eggshell crackling' may be obtained.

The second form is found most commonly in the upper end of the tibia, or some such cancellous mass. It consists of a hollow cavity, filled with blood. Several distinct arterial twigs may open into it, and the overlying bone is thinned and absorbed. It is probable that the majority of such cases are in reality due to the breaking down of sarcomata of extreme tenuity.

The **Treatment** of these cases necessarily varies with the condition found after a preliminary incision into its substance, which should always be made after rendering the limb bloodless. Where it seems probable that the condition is not associated with malignant disease, or is merely due to a myeloid tumour, the cavity should be well scraped, swabbed out with pure carbolic acid, and then firmly stuffed with gauze, so as to obtain healing by granulation from the bottom. In other cases amputation is the only treatment.

**Hydatid Disease of Bone** — The cancellous tissue of bones occasionally becomes the site of hydatid development, any part either of the medullary cavity or of the ends being involved. The bone becomes expanded, with all the symptoms of an endosteal growth. Considerable deformity may occur, and when the compact layer has become sufficiently absorbed, spontaneous fracture may follow. In this affection there is no limiting wall, the small daughter cysts being diffused through the affected area. A diagnosis is little likely to be made (at any rate, in this country, where hydatid disease is so rare) prior to an exploratory incision. **Treatment** — If all the cysts can be removed without interfering with the integrity of the shaft, a recovery, with good subsequent utility of the limb, should follow. Where, however, the disease has encroached widely on the bony tissue, whether spontaneous fracture has occurred or not, amputation holds out the only prospect of cure.

## CHAPTER XXI

### INJURIES OF JOINTS—DISLOCATIONS

**Sprains and Strains** result from sudden violence applied to a joint, either directly or indirectly, as in the football field or in many laborious occupations. They consist in a tearing or stretching of the synovial membrane, partially detached portions of which may be tucked inwards, or of ligaments, which in bad cases may be torn from their attachments to the bones. The accident itself is associated with severe pain, and is immediately followed by more or less hæmorrhage into the surrounding tissues, or into the articular cavity. Inflammatory effusion follows, and, unless wisely treated, persistent weakness and pain in the joint, either from the formation of adhesions, or from imperfect repair of the ligaments, may result. A neglected sprain may originate tuberculous disease in those who are so predisposed, whilst osteo-arthritis is a by no means uncommon sequela. If the patient is in a bad state of health at the time of the injury, an attack of acute infective arthritis may be determined. **Treatment**—The joint should be firmly supported by a wet bandage as soon after the accident as possible, in order to limit the amount of effusion. The part is raised and kept quiet, and the bandage dabbed over with evaporating lotion from time to time. In the slighter cases the patient may be allowed to use the limb in a few days, the part being supported by strapping or an elastic bandage, but in severe sprains it may be necessary to keep the part absolutely at rest for a much longer period, before the pain and tenderness disappear. Friction with stimulating liniments, douching the joint alternately with hot and cold water, massage, passive and active movements, and finally exercises against resistance, are useful in restoring the limb to full functional activity. Splints are only required when the ligaments are badly torn.

**Penetrating Wounds of Joints** are often accompanied by an escape of synovia, which is recognised as a glairy, oily fluid, floating perhaps on the surface of the blood, if, however, the aperture is small, this may not occur. It is always followed by a certain amount of reaction, the character of which depends on whether or not the joint is infected. If no infection has taken place, and the joint is kept quiet, a simple synovitis ensues, and soon passes off, if,



however, micro organisms have entered, acute arthritis probably supervenes, leading to destruction and disintegration of the joint (For symptoms and treatment, see p 652) A penetrating wound, even if untreated, does not necessarily become septic, thus, if the lesion is produced by a small clean instrument, and especially if this is inserted in a slanting direction, so that the wound is valvular, or if the incision is a large one, allowing free vent to all discharges, recovery without septic inflammation is possible

**Treatment** —If the wound is small, and the surgeon has reason to believe that the instrument inflicting it was aseptic, the external skin should be thoroughly purified, and an antiseptic dressing applied. A careful watch must be kept upon the condition of the joint, and upon the temperature of the patient, as soon as any signs of acute arthritis manifest themselves, free incisions are made into the joint, so as to relieve tension and allow the cavity to be irrigated. If, however, the wound was inflicted by a dirty instrument, and there is but little doubt that the joint has been penetrated, it is most important to make certain of this fact. For this purpose the wound should be enlarged so that its depths may be purified, and then carefully examined. If it is found that the cavity has been opened, the aperture should be increased in size so as to allow it to be washed out and a drainage-tube inserted, if acute arthritis supervenes, it must be treated in the usual way.

### Dislocations

Although the term 'dislocation' is most commonly applied to a forcible displacement of one of the bones entering into an articulation, as the result of an injury, it must not be forgotten that congenital and pathological displacements also exist.

**Congenital Dislocation** —This term is applied generally to any defect of a joint présent at birth, but is really a misnomer, since the condition is almost always due to an error of development, as a result of which a normal location of the bony constituents has never been present, and hence a *dislocation* cannot have taken place. The hip-joint is most frequently affected, but similar malformations have occurred in the shoulder, wrist, and jaw, whilst the patella may be congenitally absent or displaced.

**Congenital Dislocation of the Hip** is by no means rare, although its causation is still quite uncertain, probably it is due in some cases to malposition of the foetus in the uterus or to some irregularity in the shape of the uterine wall, *e g*, such as results from the presence of fibroids. The malformation is frequently bilateral, more commonly unilateral, it occurs rather more frequently in girls than in boys (53 47 per cent). It often passes unnoticed until the child begins to walk, and then the characteristic signs become evident. The limb is shortened and flexed on the pelvis, owing to the traction of the ilio-psoas muscle, necessitating a considerable amount of lordosis to maintain the body in a vertical position (Fig 215), whilst scoliosis

is well marked in one-sided cases. Since the head of the femur is displaced from the middle line, a gap is usually noticed between the thighs close to the perineum. Considerable adduction of the lower end of the femur (Figs 213 and 214) may result from muscular contraction (adductors), and in bilateral cases a scissor-leg deformity may ensue. The patient's gait is of a curious waddling character, which becomes very marked if one side alone is affected. Since the head of the bone is only maintained in position by its ligamentous and muscular attachments, it can often be drawn down at first, and

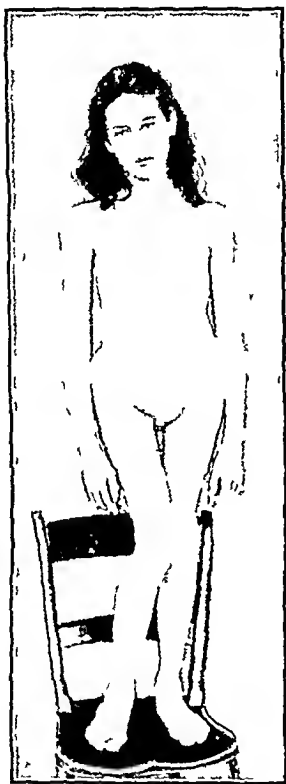


FIG 213



FIG 214

FIGS. 213 AND 214 — CONGENITAL DISLOCATION OF BOTH HIPs IN A GIRL OF FIFTEEN YEARS SEEN FROM THE FRONT AND BACK (FROM PHOTOGRAPHS KINDLY LENT BY MR J JACKSON CLARKE)

the leg thus lengthened to the extent of an inch or two, moreover, it is often easy to reduce the displacement and put the head of the bone in the acetabulum in children that have not walked much. It is sometimes necessary to invert, sometimes to evert, the limb, as well as make traction, in order to accomplish this, the head of the bone not being always in the same place. At a subsequent date strains to the limb are almost entirely borne by the ligamentous tissues, and hence attacks of synovitis are common.

The Pathological Anatomy varies considerably according to whether or not the child has walked. At *birth* the head and neck are sometimes nearly normal in shape, and located near the acetabulum, generally, however, the head is rather small and perhaps flattened



FIG 215 — SIDE VIEW  
OF SAME PATIENT TO  
SHOW THE EXTREME  
LORDOSIS

at the spot where it rests against the innominate bone, and the neck is short and stunted. The ligamentum teres is long, thin, and band-like. The acetabulum is smaller and more shallow than usual, it can often receive the head of the bone, though it cannot retain it. This is stated by Lockwood to be due to the absence of the cartilaginous rim, but this explanation is certainly not true in all cases. The capsule is large and roomy. *After the child has walked*, sundry modifications make themselves evident. The head of the bone becomes more and more displaced, so that it may finally lie well above the acetabulum on the dorsum ilii (Plate XXVII). The capsule becomes stretched over the displaced head, and much thicker than usual, the ligamentum teres is stretched. The head of the bone is considerably altered and often much deformed, the acetabulum becomes triangular in shape, owing chiefly to want of growth of the iliac portion, whilst the muscles are necessarily modified as to their length. A new, but very imperfect, acetabulum forms on that portion of the dorsum ilii where the head of the bone usually rests.

**Treatment**—Should a diagnosis be made before the child has commenced to walk, there is no reason why treatment should not be instituted at once. The head of the bone can usually be placed in its socket, and is kept there by fixing the limb in a position of abduction, whilst inward pressure is made over the trochanter with a screw apparatus. Schede has by this means converted the unstable articulation into a stable one. Such treatment will last from six to twelve months. Others have effected the same result by prolonged traction.

At a later age (up to five or six years) Lorenz's bloodless method of treatment may be employed with good hopes of a successful issue in unilateral cases. (1) The head of the bone is first drawn down to the level of the acetabulum. Some surgeons recommend this to be effected by gradual extension, others do it at one sitting under an anæsthetic. The adductor muscles are the chief hindrance, and will require a good deal of kneading, or even possibly section with a tenotome. (2) The head of the bone is to be replaced in the

PLATE XXVII



DOUBLE CONGENITAL DISLOCATION OF THE HIP



acetabulum, and as this cavity is small and chink-like, and sometimes covered in by the front of the capsule, a good deal of difficulty may be here experienced. The limb is fully flexed and then forcibly abducted, extended and everted, no undue violence being permissible, or the bone may be fractured. The head of the bone can sometimes be felt to slip into the acetabulum, and the manœuvre should be repeated several times, as it were, grinding the head of the femur into the acetabulum. (3) The limb is then put up in plaster of Paris from the pelvis to the knee in a position of abduction and slight eversion, and with the leg flexed. It is maintained in this position for ten or twelve weeks, and it is well to ascertain by skiagraphy that the bone has not slipped. At the end of that period it will probably be found that a less degree of abduction will suffice in order to keep the bone in place, and a fresh case of plaster is applied with the limb in this new position, the extension and outward rotation being maintained. As soon as possible the child is encouraged to walk on the limb in this position of abduction, so as to force the head of the bone still deeper into the acetabulum, crutches are required at first, but he will soon do without them. The plaster casing is usually needed for six months.

In older children (from five to ten years) *operative treatment* can be undertaken with some prospect of success. Hoffa and Lorenz have been the great exponents of this proceeding; though for children under five years they both admit the value of the bloodless method. Their operations consist in opening the joint from the back and front respectively, shaping up the head of the bone, enlarging the acetabulum so that the head can be replaced in it, and dividing any tense structures which prevent reduction. The limb is subsequently immobilized in a position of eversion and abduction, but for as short a time as possible. Even if ankylosis results, the patient's gait is considerably improved.

**Pathological Dislocations** are produced as the result of some intra-articular affection, *e.g.*, tuberculous disease, osteo-arthritis, Charcot's disease, etc. It is unnecessary to describe them here.

### Traumatic Dislocations

**Causes**—These are divided into the predisposing and exciting. Under the former head may be included some anatomical peculiarity of the joint, such as the shallow socket of the glenoid cavity, or some weakness of the muscles or ligaments which control the movements of the articulation. Dislocations are rare in children, since any violence directed to a joint or its neighbourhood is more likely to lead to an epiphyseal separation. Moreover, in old people the bones become brittle, and thus fractures, rather than dislocations, are produced, hence the latter lesions are almost limited to adults, and, owing to their greater exposure to injury, occur in men rather than in women.

The Exciting Causes are the application of external violence and

muscular force, acting alone or in combination. The former may be direct, but is more commonly indirect, the force being applied at a distance from the joint. Muscular-action by itself can only produce dislocation in certain joints, which by their peculiar conformation are predisposed to it, the head-of-the humerus, the patella and condyle of the jaw, are the bones most often affected in this way. If, however, the ligaments of a joint have been stretched by previous disease or displacement, recurrent dislocations, the result of muscular action, are not unusual.

The term *complete dislocation*, or *luxation*, is applied to that condition in which the articular surfaces of the bones are completely separated from one another. An *incomplete dislocation*, or *subluxation*, is one in which the surfaces are only partially separated.

A *compound dislocation* is one in which the skin has been ruptured and a communication established with the external air. A *complicated dislocation* is one in which there has been some associated injury of vessels, nerves, or viscera. The term *fracture-dislocation* is one applied to a condition in which a dislocation is complicated by fracture of one or both bones involved.

The Signs of a dislocation are as follows: (1) The evidences of a local trauma, e.g., pain, bruising, and swelling of the soft tissues, due to their laceration and the effusion of blood into them, the amount of this varies in different cases, (2) deformity of the limb, due to the articular end of the displaced bone being in some abnormal position, where it can often be felt and sometimes seen, and (3) restricted mobility of the affected joint, and hence-impairment of function of the limb. The degree to which this latter phenomenon obtains is necessarily variable, but, as a rule, it is very marked, if, however, fracture is also present, passive movements may be possible, though associated with pain and crepitus.

The Effects produced by a dislocation extend to all the structures entering into and surrounding the site of injury. The ligaments are partially or completely torn, the bony surfaces are not unfrequently fractured, especially in closely-fitting hinge joints, such as the elbow and ankle, the cartilages may be bruised, or portions of them detached, and neighbouring muscles and tendons lacerated and displaced, adjacent vessels and nerves are often contused or compressed. Considerable effusion of blood is always present, infiltrating the whole area involved.

The character of the injury explains the difficulties that are met with in its reduction. These arise from two main causes: (a) The anatomical structure of the joint and its ligaments, resulting in the hitching of bony prominences against one another, whilst the head of the bone does not always lie opposite the hole in the capsule through which it originally passed. In a few cases the end of the bone may be grasped by neighbouring ligaments and muscles in such a way as to render its replacement a matter of the greatest difficulty. (b) Muscular-contraction also constitutes an obstacle, which, though formerly difficult to counteract, is now readily overcome by the use

of anæsthetics. Not only does the patient maintain the limb in a condition of rest by a voluntary tonic contraction, but it becomes fixed by the involuntary passive tension of the displaced muscles. Moreover, clonic spasms may arise from the direct or reflex irritation of nerves, and these the patient is quite incapable of controlling.

When once reduced, Nature soon restores the part, so that in many cases no permanent lesion remains, although in some the rent in the capsule does not heal firmly, leaving the joint weak and liable to a recurrence of the displacement, while intra-articular adhesions, or the cicatricial contraction of the injured ligaments and muscles, may cause some loss of mobility.



FIG. 216.—OLD-STANDING SUBCORACOID DISLOCATION OF THE SHOULDER, SHOWING ATROPHY OF TRUE GLENOID CAVITY, TOGETHER WITH FORMATION OF NEW JOINT AND ALTERATION IN SHAPE OF HEAD OF BONE. A, VIEW FROM THE FRONT. B, FROM THE OUTER SIDE. (FROM COLLEGE OF SURGEONS' MUSEUM.)

If a dislocation is *allowed to remain unreduced*, the true articular cavity becomes shallow and partly filled up by a transformation of its cartilage into fibrous tissue, whilst the displaced head of the bone becomes adherent to the structures amongst which it lies, as the result of a plastic inflammation, either dense fibrous adhesions are formed, or a new false joint (*pseudarthrosis*). The articular cartilage is eroded, and the exposed bone eburnated and sclerosed, whilst, owing to chronic periostitis, the end of the shaft may be considerably deformed. The portion of bone upon which the displaced head rests undergoes changes, partly atrophic (from pressure), partly hypertrophic (as a result of



chronic periostitis), whereby a new socket is produced (Fig 216). Neighbouring muscles are secondarily shortened, and accommodate themselves to the abnormal position of the limb, and tendons which have been torn gain fresh attachments. These changes necessarily interfere more or less seriously with the power of the limb and the movements of the joint.

**Treatment** — The treatment of dislocations consists in the reduction of the displaced bone with as little delay as possible. There are two chief methods of gaining this end, viz, manipulation and extension.

*Manipulation* is always the best means to employ where practicable, less injury being sustained by the surrounding tissues. It consists in moving the limb in such directions as shall cause the displaced end to retrace the course that it has already taken, through the rent in the capsule to its normal position. The shoulder and hip joints are more amenable to this method of treatment than hinge joints. Anæsthesia will be required in difficult cases. The special manipulations needed in any particular instance are detailed under the various joints.

*Extension* is employed to overcome muscular and other forms of resistance, so as to draw the bone back into its original position. In order to make this effectual, the parts above the dislocation are steadied by some *counter extending* force applied either by the hands of an assistant, or by a belt or towel, or by the knee or foot of the surgeon. Extension may be made by the hands, or a firmer grip may be maintained, and greater force used, by applying a bandage or a jack-towel to the limb by means of a clove-hitch. In a few cases, the force may be exerted through some form of multiplying pulley, fixed at one end to a hook or staple, and at the other end to the loop of a towel or bandage attached to the limb. When any such contrivance is employed, precautions must be taken to prevent the soft tissues from being injured. A useful plan consists in applying a damp bandage at the point from which traction is to be made, and over this a thick skein of worsted in the form of a clove-hitch, the loop being attached to the hook of the pulley. The extension must be made continuously, no-jolting-or-jerking action is allowable, or considerable mischief may ensue. Since the introduction of anæsthetics, however, pulleys have been very rarely required, except in dealing with old-standing cases.

Reduction, however produced, is usually accompanied by a sudden and distinct snap or suction sound, due to the contraction of muscles, unless the patient is deeply under an anæsthetic, and the muscles are absolutely relaxed. The limb is subsequently kept at rest for some days, to allow the rent in the capsule to heal. Cooling lotions are applied to reduce the swelling, and at the end of ten-days or a fortnight passive movements commence, together with friction and massage of the soft parts.

*The treatment of unreduced dislocations* is often a matter of considerable difficulty. Attempts to reduce them may be undertaken up to two or three months, but no undue violence is permissible, owing to the fact that adhesions to neighbouring parts may thereby be ruptured, and the main vessels or nerves endangered. The use of

pulleys has been sometimes recommended, but so many accidents have been reported, varying in severity from laceration of the skin to actual avulsion of the limb, that it is better to discontinue such treatment if it has failed on its first application.

The amount of mobility possible in an unreduced dislocation varies a good deal in different cases, and the character of the treatment is mainly governed by this. If movement is tolerably free, and not particularly painful, massage and manipulation may be undertaken, and a very useful limb result. Where, however, movement is both painful and limited, operative treatment should be undertaken, subcutaneous section of muscles and tendons has been practised, but without much success, and the risk, owing to the fact that the peri-articular structures are displaced and distorted, is so great as to render such a procedure unadvisable. Two chief methods of operative treatment are applicable (1) Reduction by an *open operation*. The head of the bone is cut down on, and freed from its adhesions to surrounding structures, the capsule of the joint being also opened and the cavity cleared, reduction may then be possible by means of manipulation or extension. A few cases of successful treatment of old-standing dislocations of the shoulder by this means have been recorded, but, as a rule, the gain derived thereby is not commensurate with the risks and difficulties of the operation, especially if a considerable interval has elapsed since the accident. (2) *Excision* of the displaced head of the bone will give the best result in most cases. In the elbow-joint it is often the only practicable treatment, and in the shoulder and hip it is usually better than attempting open reduction.

*Compound dislocations* are almost always serious lesions, for not only is the skin lacerated, and the joint exposed to the risk of septic contamination, but adjacent vessels and nerves are liable to injury. Unless efficient treatment is adopted, suppurative arthritis ensues, leading to disorganization of the articulation, with subsequent ankylosis, or, in the case of larger joints, possibly to death from pyæmia and septic poisoning. The treatment consists in the routine antiseptic treatment of the wound, together with reduction of the dislocation. If necessary, the opening in the skin must be enlarged, in order to allow of the replacement of the bone, and should the latter structure be much bruised or injured, it may be advisable to resect it at once. If, however, vessels and nerves are also injured, or if the patient is old or debilitated, amputation may be required.

### Special Dislocations

Dislocation of the Lower Jaw forwards is not a very common accident, and usually results either from muscular action, or from a blow on the chin when the mouth is widely open, as in gaping, laughing, or attempting to take a large bite. It has also been produced in dentistry by a violent strain during tooth drawing, or from digging out roots with an elevator. In some persons the accident happens

with the greatest ease, and constantly recurs, owing probably to laxity of the capsule or insufficient development of the eminentia articularis

The *mechanism* of the dislocation is as follows. When the mouth is opened, the condyle of the jaw slips forwards on to the eminentia articularis, and it requires very little force to displace it still further into the zygomatic fossa (Fig 217). The inter-articular cartilage sometimes follows the condyle, and the attachment of the external pterygoid muscle to that structure and to the bone explains the occurrence of dislocation from muscular action.



FIG 217 —DISLOCATION OF JAW

The displacement may be unilateral or bilateral, more frequently the latter. The mouth remains widely open, the teeth and the jaws being separated by an interval of about an inch. The lower jaw projects unduly, and is fixed, saliva dribbling over the lip, speech and deglutition are impaired, the pronunciation of the labial consonants being especially difficult.

A hollow can be detected immediately in front of the tragus, where the condyle is normally lodged, and in front of this hollow the condyle can be felt, being recognised by the slight amount of passive movement still possible. A finger in the mouth may define the coronoid process in an abnormal position beneath the zygoma.

When the dislocation is unilateral, the symptoms are much less marked. Some amount of movement of the jaw still remains, whilst the chin is displaced towards the sound side.

**Treatment** —Reduction is usually easy. All that is needed is to depress the condyle below the level of the eminentia articularis, when the masseter, temporal, and internal pterygoid muscles speedily draw it back into the glenoid cavity. The patient is seated in a chair, the surgeon standing in front protects his thumbs with thick napkins, and introduces them into the mouth, pressing upon the lower molar teeth. Pressure is continued in a downward and backward direction until the condyle is free, and then the chin is raised by the fingers on either side. The jaw is kept at rest for a few days by means of a four-tailed-bandage.

A few cases are on record of displacement of the condyle of the jaw *backwards*, associated with fracture of the tympanic plate and tearing or separation of the cartilage of the auricle, leading to bleeding from the ear. Displacement *upwards* into the cranial cavity through the roof of the glenoid fossa has also been described, the patient in one case dying of meningitis.

**Dislocation of the Sternal End of the Clavicle**—In spite of the apparent weakness of this joint and the great strains to which it is subjected, dislocation is uncommon, owing to the strength of the ligaments surrounding it, particularly of the rhomboid, the clavicle being more easily broken than displaced. The cause of such displacements is violence directed to the acromial end of the clavicle. If the force acts from in front, the bone may be thrown forwards, if from above, downwards and inwards, the upward dislocation may occur, if the shoulder is driven forwards and inwards, the head of the bone may pass backwards. Three varieties are described, according to whether the head of the bone travels forwards, backwards, or upwards.

In the forward dislocation the end of the bone lies on the anterior surface of the manubrium, where it can be easily detected, all the ligaments of the joint are torn, except, perhaps, the interclavicular. The point of the shoulder is approximated to the middle line. *Treatment*—Reduction is effected by placing the knee against the spine between the scapulæ, and drawing the shoulders backwards, the elbow on the affected side being kept in front of the mid axillary line. The displacement is very likely to recur, and to prevent this a pad is kept over the end of the bone by a figure-of-8 bandage, whilst the point of the shoulder is pushed outwards by placing a pad in the axilla, and binding the arm to the side. It is advisable to keep the patient in bed for a few days, so as to give the ligaments a better chance of re-uniting, but some amount of forward displacement is very likely to persist. No bad result follows, even should the dislocation remain unreduced.

The backward dislocation is not often met with. The head of the bone lies behind the upper part of the sternum, close to the origin of the sterno hyoid and sterno-thyroid muscles. All the ligaments are ruptured, including the rhomboid. A depression is felt in the usual position of the head of the bone, which may be sometimes detected lying deeply in the superior mediastinum. The shoulder is thrown forwards, and situated nearer the middle line of the body than usual, whilst the movements of the head and neck are painful and limited. Pressure of the bone upon the trachea, œsophagus, and vessels of the neck, gives rise to difficulty in breathing and swallowing, whilst the consequent congestion of the head may even cause semi-coma. Reduction by extension of the shoulders backwards is usually accomplished without much trouble. In cases of difficulty, a firm pad can be placed in the axilla, and the shoulder levered outwards by using it as a fulcrum, the elbow being pressed to the side. It is retained in position by keeping the shoulders well extended by the use of two handkerchiefs, as suggested in the treatment of fractured clavicle. If the condition cannot be reduced, and serious symptoms of pressure result, the head of the bone should be excised.

The upward dislocation is one of extreme rarity. The head of the bone is felt in front of the trachea, in which situation it may compress both windpipe and œsophagus, especially when the patient sits up or

leans forwards To effect reduction, a pad is placed in the axilla, and the arm pressed inwards over it, the elbow is subsequently bandaged to the side and well elevated A pad is at the same time kept over the end of the bone, but it is very probable that some amount of displacement will persist

**Dislocation at the Acromio-clavicular Joint** consists in the acromion being forced either above or below the outer end of the clavicle, more commonly the latter The displacement is easily recognised by the abnormal prominence of one or other of the bones (Fig 218) It

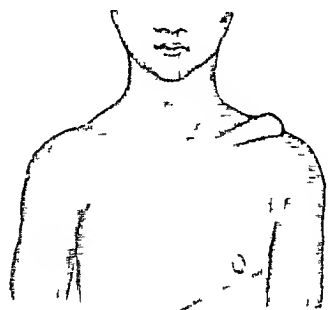


FIG 218—DISLOCATION  
DOWNWARDS OF ACROMION  
FROM THE END OF THE  
CLAVICLE (TILLMANN'S)

usually results from violence directed to the scapula No difficulty is experienced in reduction, but the displacement is very liable to recur, especially in the more common form The elbow is then flexed to a right angle, and pads of lint or small towels placed over the acromion and beneath the elbow, a bandage or strap is then applied over the shoulder and under the elbow, and suffices to maintain the bone in position The strap is kept from slipping by passing a bandage under it round the opposite side of the chest Should the displacement persist, and give rise to pain or impair the movements of the arm, the bones may be wired together after

removing the cartilaginous surfaces

A condition is sometimes met with, described as a **Dislocation of the Lower Angle of the Scapula**, or, better, **Winged Scapula** It is characterized by projection backwards of that part of the bone when the arms are thrust forwards, and is due rather to paralysis of the serratus magnus and rhomboids than to slipping of the fibres of the latissimus dorsi from the lower angle, as was formerly supposed The paralysis results from chronic neuritis, traumatic or otherwise, of the roots of the fifth and sixth cervical nerves, which may be found tender on pressure

The **Treatment** consists in the use of massage and of the faradic current, whilst, if persistent, a properly-applied apparatus may correct the deformity

**Dislocation of the Shoulder** occurs almost as frequently as all the other dislocations of the body put together The shallowness of the glenoid cavity, the size of the head of the humerus, the laxity of the capsule, the extent and force of the movements possible, and the exposed position of the shoulder, explain the great frequency of the accident It usually results from falls upon the hand or elbow, the arm at the time of the accident being widely outstretched, to enable the individual, if possible, to save himself The weak lower and inner part of the capsule receives the chief portion of the shock, and yields, the head of the bone being primarily displaced downwards into the axilla (subglenoid variety), and then, according to the direc-

tion of the force, or the character of the subsequent manipulations, the head travels either forwards (subcoracoid or subclavicular dislocation) or backwards (subspinous). Falls on the elbow or shoulder may, however, cause a direct forward or backward displacement.

The Signs of a dislocation of the shoulder are sufficiently obvious, and certain characteristic features are present in almost all varieties. (1) The shoulder looks flattened, owing to displacement of the head inwards (Figs 161, B and 221), and as a result of this the acromion process is unduly prominent, and a hollow, felt below it, occupied by the tense deltoid. (2) The head of the bone lies in some abnormal position, and the glenoid cavity is empty. (3) The elbow is displaced away from the side, and it is impossible to make it touch the chest wall at the same time that the hand is placed on the opposite shoulder (Dugas' test), this does not always obtain in the subcoracoid type

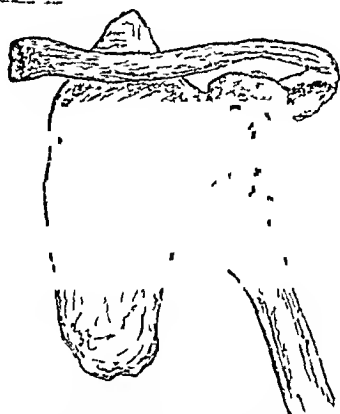


FIG 219 —SUBGLENOID DISLOCATION OF SHOULDER (TILLMANN'S)

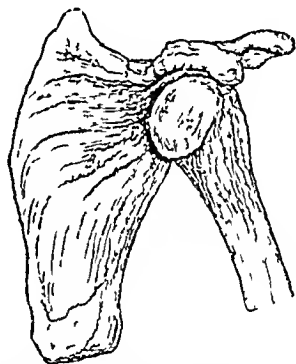


FIG 220 —SUBCORACOID DISLOCATION OF SHOULDER (TILLMANN'S)

(4) The vertical measurement round the axilla is increased in all the varieties (Callaway's test), whilst inspection reveals a lowering of the anterior or posterior axillary fold (Bryant's test). (5) A ruler or straight edge can be made to touch both the acromion process and the outer condyle of the elbow in most cases of dislocation (Hamilton's ruler test), this is impossible when the head of the bone is in its normal position, but can also occur in fractures of the anatomical neck. At the same time, the usual signs of a dislocation, viz., rigidity and local bruising, are also present.

**Subglenoid Dislocation** (Fig 219) is always the primary condition when the accident is due to a fall upon the outstretched arm, but is not commonly seen, since the head of the bone subsequently slips up under the coracoid, as before stated. The head of the bone passes down into the axilla, resting against the outer border of the scapula below the glenoid cavity, between the subscapularis above and the teres minor below, with the long head of the triceps behind. The capsular ligament and muscles passing to the tuberosities are torn, whilst the axillary vessels and nerves may be seriously compressed, leading to

numbness of the fingers. The head of the bone is felt in the axilla, and the anterior axillary fold is much lowered, the elbow is directed away from the side and slightly backwards, the arm is lengthened, perhaps to the extent of 1 inch, whilst the fore-arm is usually flexed.

A few cases have been recorded in which the arm was abducted and displaced vertically upwards, although the head of the bone was in the usual position of a subglenoid dislocation. This variety is known as the *luxatio erecta*.

**Subcoracoid Dislocation** (Figs 220 and 221) is, without doubt, the most common form. The head of the bone lies under the coracoid process on the anterior part of the neck of the scapula, immediately in front of the glenoid cavity, the anatomical neck impinging on

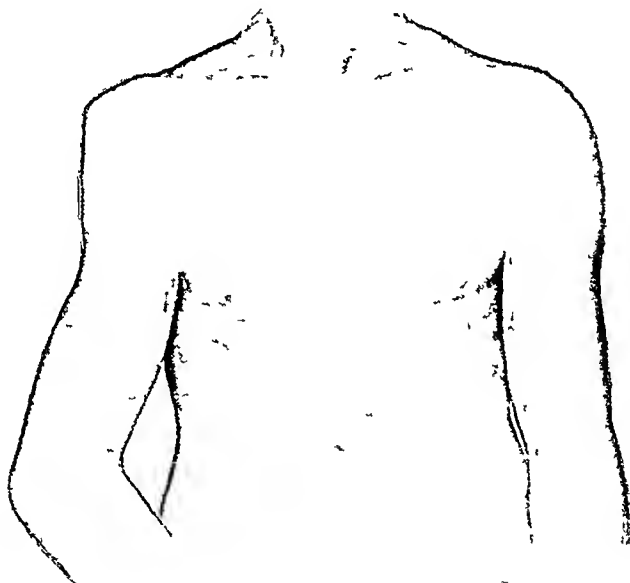


FIG 221.—SUBCORACOID DISLOCATION OF THE RIGHT SHOULDER

its anterior border. In this position it is above the tendon of the subscapularis, which is either torn or stretched over the neck as a tense band, and may considerably impede reduction. Two forms of this displacement are described by Malgaigne, according to whether the muscles attached to the great tuberosity are intact, resulting in marked external rotation of the limb (subcoracoid variety), or whether they are lacerated, or even the great tuberosity itself pulled off, the humerus being then rotated inwards (intra-coracoid variety). In both types the elbow is displaced backwards and outwards, and the head of the bone can be usually felt with ease, especially on rotation of the arm, under the outer third of the clavicle, except in stout people or where the muscles are greatly developed. Comparatively little alteration in the length of the arm is produced.

The **Subclavicular** variety is very uncommon, and merely an exaggeration of the subcoracoid. The head of the humerus passes further inwards, and lies deeply under the pectoralis major, on the second and third ribs. The capsule and surrounding muscles are much lacerated, or perhaps the great tuberosity torn off, the elbow is markedly separated from the side and directed a little backwards, whilst distinct shortening is present.

The **Subspinous Dislocation** (Fig 222) is unusual. The head of the bone lies in the infraspinous fossa, immediately behind the glenoid cavity, between the infraspinatus and teres minor muscles, the subscapularis being generally torn. Malgaigne states that the head of the humerus is most commonly found resting on the posterior edge of the glenoid cavity immediately below the acromion process (sub-acromial variety). The elbow is displaced considerably forwards, but can be made to touch the chest wall, the arm is rotated inwards, so that the hand is thrown across the front of the body. There is usually a marked hollow beneath the coracoid process, whilst a distinct prominence is caused by the head of the bone in its false position. The length of the limb is frequently unaffected, or if any change is present, the arm is slightly lengthened.

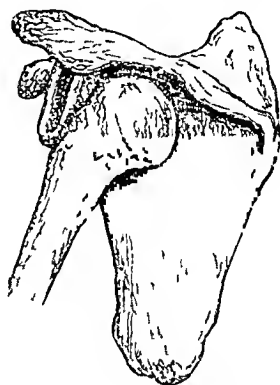


FIG 222 —SUBSPINOUS DISLOCATION OF SHOULDER (TILLMANN'S)

Three or four cases have been described of what is known as a **Supracoracoid Dislocation**. The head of the bone is here displaced upwards, and either the coracoid or acromion process is broken, i. e. commonly the former. Replacement with crepitus is easily obtained, but the dislocation is liable to recur.

The **Treatment of Dislocation of the Shoulder** consists in reduction by manipulation or extension.

1. For *reduction by manipulation* an anæsthetic is advisable, but not absolutely essential, and preferably chloroform, although when the patient is in a bad state for the administration—*i. e.*, with his stomach full of food—ether may be preferable. It is only right to draw attention to the fact that a large number of fatal cases of chloroform administration have been reported as occurring in the treatment of shoulder dislocations, this is due mainly to two causes, *viz.*, the deep anæsthesia required, and the want of preparation of the patient. The greatest care must therefore be exercised in giving the anæsthetic.

Many different methods of manipulation have been suggested, of which the following are the more important. Not unfrequently, when the muscles are relaxed, any slight rotary movement suffices to 'put the bone in'.

**Kocher's Method for Subcoracoid Dislocations**—The surgeon standing in front of his patient, who is seated or reclining, and supported by



an assistant, grasps the elbow after flexion of the fore arm, and presses it to the side. The arm is now rotated firmly and steadily outwards until the fore-arm is at right angles to the body, when distinct resistance will be felt. This causes the head of the humerus to roll out beneath the acromion, and is often sufficient to effect reduction, but if the limb is still displaced, the arm should be drawn forwards to the median line and elevated almost to a right angle with the trunk, with the hand still abducted and everted, whilst finally the arm is rotated inwards so as to carry the hand towards the opposite shoulder, and the elbow lowered. The value of this plan, according to Kocher, turns on the fact that the posterior part of the capsule and the scapular tendons inserted therein are usually untorn and stretched tightly across the glenoid fossa. Rotation outwards relaxes this structure and removes it from the fossa, whilst the rent in the capsule gapes, but owing to the fact that the upper and lower margins of the opening are still tight, the head of the humerus remains fixed against the neck of the scapula until the elbow is carried forwards and raised. The upper part of the capsule then relaxes, and the lower part, which remains tense, guides the head of the bone into the joint.

*Smith's Method* varies somewhat in its application, according to whether the head of the bone is displaced anteriorly or posteriorly. For anterior displacements the surgeon stands in front of the patient, and grasps the shoulder, using the right hand for the right shoulder and the left for the left, so that the thumb rests on the head of the bone, and the fingers grasp and steady the scapula. With the other hand he seizes the arm near the elbow which has been flexed, and raises it from the side, extending and everting it. Having thus raised it to a right angle, the limb is steadily and continuously circumducted inwards, the thumb following the head of the bone and assisting it to reach the lower and under side of the capsule, and thus enter the socket through the rent. For the subspinous dislocation, the surgeon stands behind the patient and grasps the shoulder with one hand, raising the arm with the other, and making extension backwards combined with external rotation, *viz.*, the limb is circumducted outwards, and finally brought to the side.

2 *Extension* may be applied in different ways, the object being to overcome the tension of surrounding ligaments and muscles. It may be applied directly downwards by the surgeon grasping and pulling on the arm, whilst his unbooted foot is used as a counter-extending force in the axilla, the patient lying flat on a mattress placed on the ground, and the surgeon sitting by the side. Another plan consists in using the knee as a fulcrum instead of the heel, the patient sitting in a chair. Occasionally the foot has been placed against the thoracic wall, and extension made directly outwards at right angles to the body, as recommended by Sir Astley Cooper White, of Manchester, suggested vertical traction, the arm being pulled directly upwards, the surgeon's foot having been placed over the acromion, the patient being in the recumbent posture. The

only objection to this last method, which may succeed when other plans fail, is that the axillary vessels are somewhat exposed to injury

**Dislocations of the Elbow-Joint** are not very uncommon, occurring particularly in young people, and are due to either direct or indirect violence. The diagnosis is often difficult from the amount of swelling that quickly follows. A careful investigation of the relative position of the bony points (p 497), and of the degree of mobility of the different parts on each other, is essential in order to arrive at a definite conclusion as to the exact nature of the lesion. In cases of doubt, a skiagraph should be taken

1 **Dislocation of Both Bones** may occur either *backwards*, *forwards*, or *laterally*

The **backward variety** (Fig 165, A) is that most often met with, it usually occurs without either the coronoid process or the olecranon being fractured, although occasionally the former is detached. If the coronoid remains intact, it sometimes becomes locked in the olecranon fossa, and renders the arm immobile, if, however, it is broken, considerable mobility of both bones occurs, with crepitus. The forearm is semi-flexed, the hand held midway between pronation and supination, and the displaced bones form a considerable swelling at the back of the joint, above which is a marked hollow, crossed by the triceps. The lower end of the humerus projects in front, and the artery and the soft parts are displaced forwards. The measurement from the acromion process to the external condyle remains unaltered, but that from the condyle to the styloid process of the radius is distinctly shortened, and the distance between the condyles and the olecranon process is increased

Dislocation **forwards** of both bones rarely occurs without fracture of the olecranon process, although a few cases of this unusual accident are on record. The displacement is readily detected, the forearm being lengthened perhaps to the extent of an inch. The arm is in a condition of flexion, and, indeed, the accident can only take place from falling backwards on the point of the elbow when in this position. The triceps muscle may be considerably lacerated

**Lateral** dislocations of the forearm are almost always incomplete and are not very frequent, the bones may be displaced either inwards or outwards, the latter being the more common. They are recognised by a careful examination of the relative position of the bony prominences

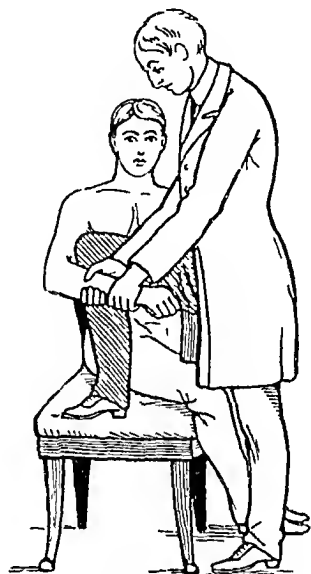


FIG 223 — REDUCTION OF BACKWARD DISLOCATIONS AT THE ELBOW

2 **Dislocation of the Ulna alone** occurs only in a *backward* direction. It is an occurrence of the greatest rarity, owing to the position and strength of the orbicular and oblique ligaments and of the interosseous membrane. If, however, the bones of the fore-arm are rotated backwards upon the head of the radius as a fulcrum, and then the fore-arm adducted, this displacement can occur without extensive ligamentous lacerations, which, indeed, have not been noted in any of the cases observed.

In the **Treatment** of the above dislocations, all that is necessary is to unhitch the interlocking bony prominences, so as to allow the bones to return to their normal positions by muscular contraction. This is usually accomplished by the method described by Sir Astley Cooper. The patient being in a sitting position, the surgeon presses

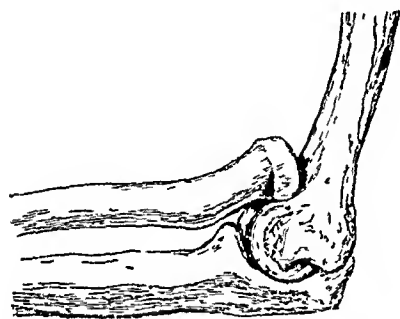


FIG. 224.—DISLOCATION OF THE RADIUS FORWARDS (PICK.)

backwards, with his knee in the bend of the elbow, against the lower end of the humerus, at the same time he grasps the patient's wrist, and slowly and forcibly bends the fore-arm (Fig. 223).

3 **Dislocation of the Radius alone** may occur either *forwards*, *backwards*, or *outwards*.

The **forward dislocation** (Fig. 224) is that usually seen, and results from falls on the hand when the fore-arm is in a state of extreme pronation. The head of the radius rests against the lower end of the humerus in the hollow above the capitellum, and the most characteristic feature consists in the inability of the patient to flex his fore-arm, owing to the bone impinging against the lower end of the humerus. It can be readily detected in this situation, rotating with the movements of the fore-arm, whilst a deep hollow is felt behind, immediately below the external condyle. The fore-arm is somewhat flexed, and midway between pronation and supination, the former act can be satisfactorily accomplished, but supination cannot be carried further than half-way. A marked fulness exists on the anterior aspect of the limb when the arm is extended. Fracture of the upper third of the ulna sometimes accompanies this accident, especially when produced by direct violence (Plate XXVIII). If this luxation is not reduced, very great impairment of the mobility of the limb results, flexion beyond an obtuse angle becoming impossible. **Treatment**—Reduction is accomplished by traction from the wrist, with the fore-arm flexed to a right angle, combined with pressure over the head of the bone. Owing to the fact that the orbicular ligament is ruptured, the deformity is very likely to recur, and hence active movements of the limb must be interdicted for three or four weeks, a pad is placed anteriorly over the head of the bone, and the limb flexed on a splint.

Dislocation backwards is less common. The head lies behind the

PLATE XXVIII



DISLOCATION OF RADIUS FORWARDS, AND FRACTURE OF UPPER THIRD OF ULNA



external condyle on the outer side of the olecranon, where it can be detected on rotating the limb (Fig 225) The fore arm is flexed, and the limb pronated Even if left unreduced, it leads to but little inconvenience

Dislocation outwards is also rare, the head of the bone being displaced to the outer side of the external condyle, where it can easily be felt, causing considerable impairment of the natural movements Reduction is accomplished without difficulty

Occasionally a rare form of dislocation is met with in which the ulna passes backwards and the radius forwards, resulting in great deformity

A very common accident in children under four years of age consists of a subluxation of the head of the radius downwards within the orbicular ligament, so that a portion of it slips up and becomes nipped between the head and capitellum It results from forcible traction of the hand, as from pulling up a child roughly after it has fallen, and is a common nursery accident, popularly known as pulled elbow The limb becomes fixed in a position of slight flexion, and with the hand pronated, and the child cries out with the pain, it is readily treated by completely flexing the limb, and subsequently extending and fully supinating it, and leaves no bad results

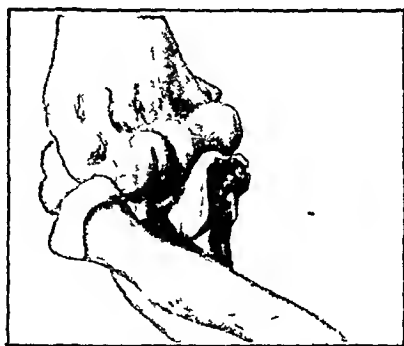


FIG 225 — DISLOCATION OF THE RADIUS BACKWARDS (DIAGRAMMATIC)

It must not be forgotten that we have here merely described the pure dislocations In actual practice complications of a serious nature are frequently present in the shape of fracture of one or both condyles, which lead to much difficulty in diagnosis These fracture-dislocations give rise to so much hæmorrhage that it is often impossible to come to a correct conclusion as to the nature of the case without the assistance of the Röntgen rays, and even then the results of treatment may be unsatisfactory So much callus is formed, and fibrous adhesions of such strength are developed, that considerable impairment of function is almost certain to ensue Probably the best line of practice is to keep the elbow at rest on a rectangular splint for a few days, to allow the immediate effects of the accident to pass off, and then to make an aseptic incision, dealing with the condition of affairs in the way best suited to the requirements of the particular case

**Dislocation of the Wrist** is a very uncommon accident, and may occur *forwards* or *backwards* The lower ends of the radius and ulna become prominent under the skin, and especially the styloid processes By this means it is easily distinguished from a fracture of the lower ends of the bones

Occasionally the radius, carrying with it the hand, is dislocated

from the lower end of the ulna, as a result of forcible pronation. This is usually described as a *backward dislocation of the ulna*, and is easily reduced by manipulation.

**Dislocations of various Carpal Bones** have been described, but the only one which is at all common is a displacement of the os magnum backwards. It forms a rounded prominence under the skin in the usual situation of the bone, which becomes more prominent on flexion, and may disappear on extension. As a rule, it is readily reduced, but is very likely to recur.

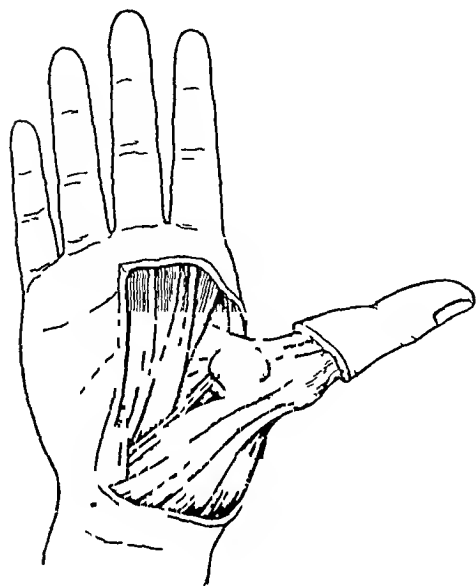


FIG 226 — DISLOCATION OF THUMB, SHOWING HEAD OF THE METACARPAL BONE PROTRUDING FORWARDS BETWEEN THE HEADS OF THE SHORT FLEXOR MUSCLE (PICK)

**Dislocations of the Metacarpal Bones and Phalanges** are not unfrequent, but need no special mention, except in the case of **Dislocation Backwards of the First Phalanx of the Thumb**. The chief interest here lies in the difficulty experienced in reduction, which was formerly attributed to the head slipping between the two portions of the flexor pollicis and being grasped by them, as a button in a button-hole. It has now been shown that there are two much more important factors, viz, the tension of the long flexor tendon, which latches round the neck (Fig 226), and the arrangement of the glenoid ligament. This fibro cartila-

ginous structure passes between the two heads of insertion of the short flexor, and is thus incorporated between the two sesamoid bones, whilst firmly attached to the base of the phalanx, it is but loosely connected with the head of the metacarpal bone, so that it accompanies the phalanx in its dislocation, and will then be situated immediately behind the head of the metacarpal, so as to prevent any attempts at reduction. **Treatment** — Traction and manipulation are always attempted in the first instance. The thumb is grasped by a suitable apparatus and hyper-extended to a right angle, thus making the head of the metacarpal project still further through the muscular interspace, and, as it were, enlarging the buttonhole. Still maintaining the traction, the thumb is rapidly flexed into the palm, the metacarpal bone being at the same time pressed inwards. Should this fail, as it often will, a purified tenotome should be inserted in the middle line of the thumb behind, immediately above the base of the phalanx, and should be pushed on till it reaches and divides

the glenoid fibro-cartilage between the sesamoid bones, this little manœuvre will at once render replacement simple

**Dislocation of the Hip**, though not very common, is a condition of extreme gravity. The depth of the socket in which the femur rests, and the strength of the muscles and ligaments surrounding the articulation, explain the comparative infrequency of the accident. It is never produced by direct violence, but always results from a force applied to the feet or knees, or, if the legs be fixed, to the back. It is rarely met with except in young people or adults, since after the age of forty-five fractures of the neck of the bone are much more likely to occur.

In considering these dislocations, the relative strength or weakness of the different parts of the capsule and its surrounding structures must be remembered. Thus, the weakest part of the capsule is placed below and behind, and the fibres here are easily lacerated; indeed, it is through a rent in this part of the capsule that the head of the bone most frequently escapes. In front, the ilio-femoral or Y-shaped ligament of Bigelow, extending from the anterior inferior iliac spine to the anterior intertrochanteric line, is a structure of much strength, on the integrity of which depends the fact whether the displaced head of the bone shall occupy some definite position or be freely moveable. Bigelow, to whom we owe so much in the elucidation of the mechanism of these dislocations, has divided them into two classes—the *regular* and the *irregular*—according to whether this ligament is intact or completely lacerated. Posteriorly, the plicated tendon of the obturator internus is the most important structure, and the position and level of the bone on the dorsum ili depends in some measure on whether it remains intact or is ruptured. It must also be remembered that the ligamentum teres is relaxed when the thigh is forcibly abducted, and is made tense by adduction.

Four chief varieties of dislocation are described, in two of which the head of the bone is displaced posteriorly, and in two anteriorly. The two former are known as the *Dorsal* and the *Sciatic* varieties, although *Dorsal below the tendon*, as originally suggested by Sir Astley Cooper, is the better appellation for the latter variety. The two anterior dislocations are known as the *Obturator* or *Thyroid* and the *Pubic*, in the former the head of the bone is located in the obturator notch, and in the latter upon the pubic ramus. The relative frequency of these dislocations is as follows: About 50 to 55 per cent of the cases are of the dorsal type, 20 to 25 per cent sciatic, 10 to 15 per cent obturator, and 5 to 10 per cent pubic. In addition to these four varieties, many other slight modifications have been described, which it will be unnecessary to further particularize.

**Mechanism**—The limb is usually in a position of abduction at the moment of dislocation, the head of the bone escaping from the capsule through a rent in the lower and back part of the ligament, and thus being primarily displaced downwards. The type of accident responsible for this is a fall with the legs widely separated, or when the limbs are drawn forcibly apart, as, for instance, when



one leg is placed on a boat just moving away from a pier on which the other is fixed. The direction of the violence, or the subsequent manipulations performed by willing but ignorant friends, or the voluntary movements of the individual, determine what form of dislocation is to be subsequently produced. If the limb is externally rotated and extended, the head travels forwards, and either the pubic

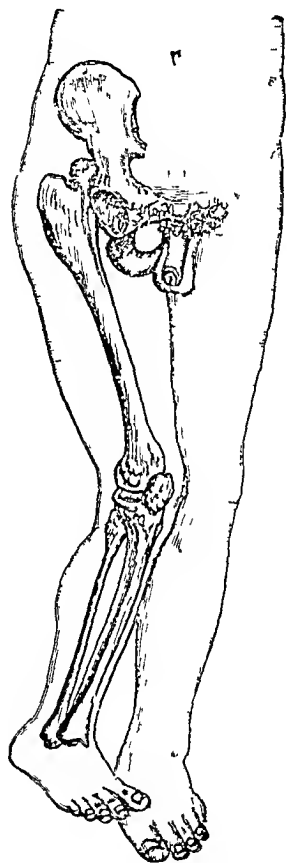


FIG 227 — DORSAL DISLOCATION OF THE HIP  
(TILLMANN'S)

or obturator variety results. If, however, the leg is inverted and flexed, the head of the bone passes backwards, and either the dorsal or sciatic form is produced. Again, in the posterior dislocations, if the obturator internus tendon remains intact, it may hitch across the front of the neck, and prevent any further upward displacement of the bone, thus giving rise to the so-called sciatic variety, but if the tendon is ruptured, or if the head of the bone slips in front of it, there is no obstacle to its upward displacement on the dorsum ilii.

Dislocation may, however, also result when the limb is in a position of adduction, a *direct dorsal dislocation* being thus produced, the head of the bone escaping from the capsule above the tendon of the obturator internus, such an accident is sometimes, but not always, associated with fracture of the posterior lip of the acetabulum. The type of violence leading to this occurrence is when a heavy weight falls on the back of a person whilst kneeling, or when, his knee being fixed, the body is thrust forwards, so that the limb is forcibly inverted. If, however, the thigh is in a position of extreme flexion, the head may be displaced below the tendon of the obturator internus, and the sciatic variety will then result.

**I Dorsal Dislocation (Fig 227)** — The head of the bone in this form is found lying on the dorsum ilii, a variable distance above and behind the acetabulum, and always above the obturator internus tendon. It may be detected on manipulation of the limb, although in muscular subjects this is difficult. The ligamentum teres is necessarily ruptured, as also the capsule, the rent being situated either below or above the obturator tendon, according to whether the dislocation is due to forcible abduction or adduction. The small external rotator muscles are usually lacerated, and perhaps even the glutei and the pectineus. The ilio-femoral ligament usually remains intact. The great sciatic nerve is sometimes compressed or contused. The trochanter is raised above Nélaton's line (p 539), and approximated to the anterior superior spine, the ilio-tibial band of

fascia is therefore relaxed, and there is considerable shortening of the limb, amounting often to 2 or 3 inches. The leg is in a position of flexion, adduction, and inversion, so that the axis of the femur crosses the lower third of the sound thigh. The knee is semi-flexed, and the ball of the great toe rests against the opposite instep, the heel is somewhat raised. A marked hollow is felt in the upper part of Scarpa's triangle, and the main vessels of the limb appear to be unsupported.

The **Diagnosis** should be easy, the only difficulty being experienced in distinguishing it from an impacted extra-capsular fracture. The character of the accident, the presence of adduction and inversion, the increased breadth of the trochanter in the case of fracture, and the abnormally placed head of the bone in dislocation, are the points to which attention must be directed.

2 **Sciatic Dislocation**, or dorsal below the tendon, is one in which the head of the bone is prevented from travelling upwards to the dorsum ilii by the integrity of the obturator internus tendon. It may occur either from forced abduction of the limb, or from extreme flexion in the adducted position. The lesions of muscles and ligaments are practically the same as for the dorsal variety. The ilio femoral ligament is uninjured.

The **Signs** resemble those of a dorsal dislocation, but are less marked. There is less shortening, often not more than  $\frac{1}{2}$  to 1 inch, the limb is flexed, adducted, and inverted, but the axis of the femur is directed across the opposite knee, and the great toe rests against the ball of the great toe of the opposite side. The head of the bone is often much less distinct, owing to the greater thickness of the glutei muscles at that level.

**Treatment of the Two Backward Dislocations** is effected in much the same way, whether the dorsal or sciatic variety is present. The most usual method is that of *manipulation and rotation*, so accurately worked out by Bigelow. The patient is anesthetized, preferably on a mattress placed on the floor. The leg is first flexed on the thigh, and the thigh on the abdomen, the position of adduction being still maintained, so that the knee extends beyond the middle line of the body (Fig 228). This position is maintained for some moments, and then the limb is freely circumducted outwards, and brought rapidly down into a position of extension parallel with the other. By this manoeuvre the tense structures in front of the joint are relaxed, and then the head of the bone is made to retrace its course towards the rent in the capsule, and finally directed upwards into the acetabular cavity. These movements are tersely summarized in Bigelow's words—'Lift up, bend out, roll out.'

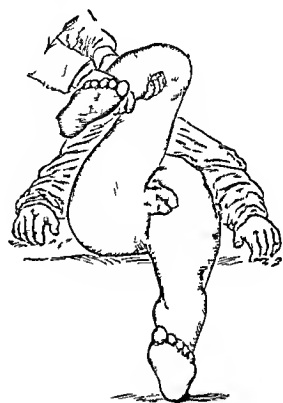


FIG 228 —REDUCTION OF DORSAL DISLOCATION OF HIP (BRIANT)

If this plan does not succeed, the following method of *traction* may be employed. The patient, lying on his back, is firmly fixed by a bandage or towel passed over the pelvis and secured to two or three hooks or staples driven into the floor. The surgeon stands over the patient, whose thigh is flexed to a right angle on the abdomen, as also the knee upon the thigh. The surgeon's arms are passed under the knee sufficiently far to enable him to grasp his own elbows, and the front of the leg is steadied against the operator's perineum. Direct and forcible traction upwards can now be made, and this is often

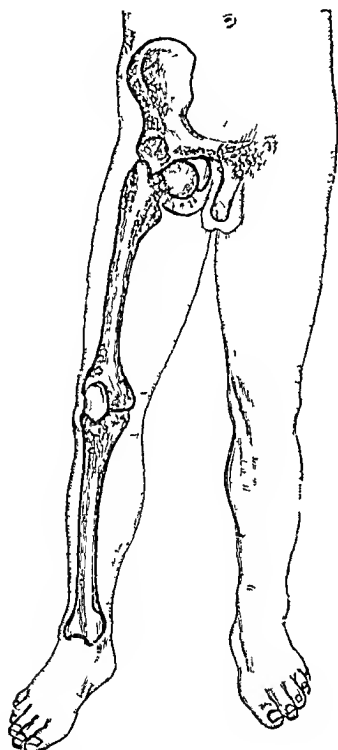


FIG 229 —DISLOCATION OF THE  
HIP OBTURATOR VARIETY  
(TILLMANN'S)

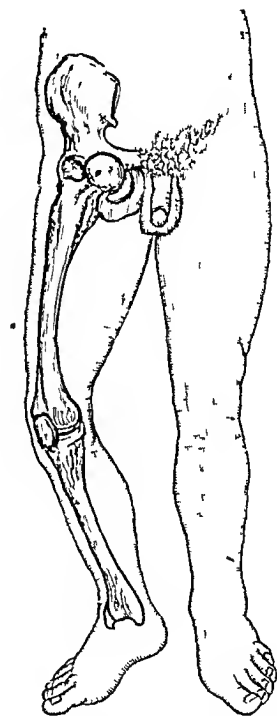


FIG 230 —DISLOCATION OF THE  
HIP FORWARDS PUBIC  
VARIETY (TILLMANN'S)

sufficient in itself to lift the head of the bone into the acetabulum. If this is unsuccessful, the movements described above can be energetically repeated in this position. The above plans, combined with the use of an anæsthetic, rarely fail in reducing a backward dislocation of the hip, and hence *extension by means of pulleys* is rarely required. If, however, it is needed, traction should always be made in the direction of the displaced limb, *i.e.*, across the other thigh, counter-extension being obtained by a jack-towel passed between the injured thigh and the perineum, and fixed to a staple in the floor, close to the head of the patient, and applied on the side of the dislocation. When sufficient force has been applied, the surgeon rotates the limb outwards

so as to allow the head of the bone to once more slip into its socket

3 **Thyroid or Obturator Dislocation** (Fig 229) —The head of the bone in this case passes downwards through a rent in the lower part of the capsule, and its position is subsequently but little altered, a slight forward and upward movement being alone superadded. The ilio-femoral ligament is untorn, but the pectineus and adductors are very tense, or may even be lacerated, the ligamentum teres is, of course, ruptured. The head lies on the obturator externus muscle, and can be detected in the perineum. The trochanter is less prominent than usual, and, indeed, its normal position may be represented by a depression. The limb is slightly abducted and everted, as well as lengthened, perhaps to the extent of 2 inches, though this is more apparent than real. It is also flexed, owing to the tension of the ilio-psoas muscle, and advanced before the other, with the toes pointing outwards. The adductor longus tendon stands out prominently, and much pain may be experienced from pressure on the obturator nerve. If the patient stands, the body is bent forwards, whilst it is interesting to note that if the dislocation remains unreduced the patient may be able to walk without much pain or inconvenience, though in a more or less stooping position.

4 **Pubic Dislocation** (Fig 230) —In this variety the head of the bone lies on the horizontal ramus of the pubes, just internal to the anterior inferior spinous process of the ilium, where it can be felt rolling under the finger on any movement of the limb. The vessels are pushed inwards, and considerable pain may be felt down the limb from pressure on the anterior crural nerve. The ilio-femoral ligament is untorn, whilst the ligamentum teres and capsular ligament are ruptured, the small external rotator muscles, with the exception of the obturator internus, are usually torn. There is marked flattening of the hip, the trochanter being approximated to the middle line and raised. The limb is shortened to the extent of 1 inch, and there is considerable abduction and eversion, so that the inner aspect of the limb looks forwards. The thigh is slightly flexed to relax the ilio-psoas muscle.

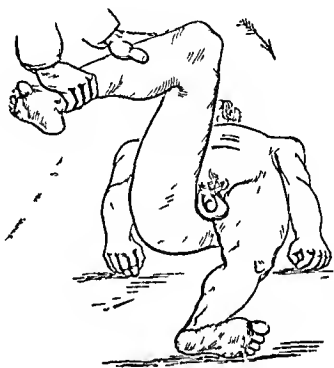


FIG 231 — REDUCTION OF ANTERIOR DISLOCATIONS OF THE HIP (BRYANT)

Treatment of the thyroid and pubic dislocations is undertaken along similar lines as for the posterior dislocations. The patient is anesthetized, the knee is flexed, as also the thigh upon the abdomen, but in a position of abduction, circumduction inwards follows (Fig 231), and on extension of the limb the head again enters the acetabulum. The thyroid variety may sometimes be reduced by upward and outward traction when the limb has been flexed to a right angle in the abducted position, the unbooted foot being placed against the pelvis to steady it.

If extension by pulleys is required in the thyroid dislocation, it is made transversely outwards across the upper part of the thigh, counter extension being obtained by means of a band passed round the abdomen. The limb, at first in a position of abduction, is subsequently adducted forcibly by drawing the ankle inwards, the band by means of which extension is being made acting as a fulcrum to lever the head of the bone into the acetabulum. In the pubic variety traction is made downwards, outwards, and backwards, and the head of the bone drawn into its socket by a towel passed transversely across the limb.

After reduction of any form of dislocation of the hip, the patient should be kept in bed with the legs tied together for about a fortnight, and then passive movement may be commenced, but with considerable caution, voluntary movements should not be undertaken for another week or two.

Should the dislocation recur, it may be due to fracture of the posterior lip of the acetabulum, or to some involuntary movements of the patient, or perhaps to the fact that the displacement has not been fully reduced. Under such circumstances further attempts at replacement should be undertaken, and the limb subsequently kept immobilized for a longer period than usual.

Irregular dislocations of the hip occur when the Y-shaped ligament is completely torn through, so that the head of the bone is not restricted, but can be moved round the acetabular cavity. Reduction is usually easy.

Dislocation of the Patella may occur *outwards*, *inwards*, or *edgewise*. A dislocation upwards resulting from rupture of the ligamentum patellæ is sometimes described, but it is scarcely to be included in the same category as the others. The displacement may be complete or incomplete, in the former the capsule is always lacerated, in the latter, not necessarily so.

The *outward* variety is much the commonest on account of the obliquity of the limb, and may result from muscular action, especially in people suffering from genu valgum, it also arises from direct violence. In either case it occurs most frequently when the limb is extended, since during flexion the bone is firmly lodged in the intercondyloid notch. When completely displaced, it lies upon the outer surface of the condyle, with its inner margin projecting forwards. In this situation it is easily felt, whilst the knee appears flattened and broader than usual, the intercondyloid notch being plainly distinguishable in the position usually occupied by the patella. It is not unfrequently, however, incomplete, and then the inner half of the articular surface of the patella lies in contact with the cartilaginous surface of the outer condyle, with its outer border projecting forwards. *Reduction* may take place spontaneously, but is usually effected by manipulation. The thigh is flexed on the abdomen, and the knee extended, so as to relax the quadriceps, and then a little pressure on its outer margin causes the bone to slip back into place. In the incomplete form, where one of the borders of the bone is lodged in the

intercondyloid notch, reduction is sometimes very difficult, and to effect it an open operation may be required

The inward dislocation is rare, being always due to direct violence. In characters and treatment it is the exact converse of those met with when the bone is displaced outwards

A dislocation edgeways, or **Vertical Rotation** of the patella, is an interesting condition in which the bone is said to be twisted vertically upon its own axis, and even to have been turned completely round. Incomplete rotation is practically identical with that just described as an incomplete lateral dislocation, whilst the complete rotation of the patella must indeed be a rare accident

Dislocations of the Knee may occur *laterally*, as also *forwards* or *backwards*. When due to disease of the joint, the backward dislocation is commonest, but when arising from traumatic causes, the lateral is the most frequent

The lateral displacements are rarely complete, and are usually associated with a certain amount of rotation, the leg is partially flexed. Reduction is effected without difficulty

Dislocation of the tibia forwards is more common than displacement backwards. It is generally complete, the lower end of the femur projecting into the popliteal space, and compressing the vessels, so that gangrene not unfrequently follows. The upper end of the tibia, carrying with it the patella, lies in front, forming a well-marked swelling with a hollow above it. There is usually considerable shortening of the limb if the articular surfaces overlap

Dislocation of the tibia backwards is a much rarer accident, and is also usually complete (forty out of fifty-five cases were complete)\*. The signs are exceedingly characteristic, the pressure effects upon the popliteal vessels and nerves often resulting in gangrene (ten cases out of fifty-five)

Reduction of either of these conditions is easily accomplished by traction on the limb, whilst the thigh is flexed, combined with manipulation in order to guide the head of the tibia into its normal position. The limb must subsequently be kept at rest on a splint for two or three weeks

Displacement of a Semilunar Cartilage (*Syn* Subluxation of the Knee, Internal Derangement of the Knee Joint) is a condition frequently met with, resulting from sprains and strains associated with torsion. In any rotary movement of the knee, which is only possible when the limb is flexed, the pressure of the condyles always tends to modify the position of the cartilages, which, moreover, are relaxed and more freely moveable on the upper surface of the tibia in flexion than in extension. Displacement of a cartilage is almost always due to a sudden strain or wrench of a rotary type, e.g., turning quickly round in such games as tennis, or slipping off the kerbstone with the knee bent. The internal cartilage is much more frequently affected than the external, and the character and extent of the lesion varies much in different cases. Not unfrequently its anterior tibial attachment is

\* Sheldon, *Annals of Surgery*, January, 1903

torn through, thereby permitting considerable lateral mobility. Its peripheral connections with the capsule and internal lateral ligament may also be ruptured, whilst sometimes a portion is more or less detached from its free border, and in other cases the cartilage has been broken across a little behind its centre. It is obvious that when once its connections have been loosened it can be displaced readily, and may pass into the intercondyloid notch, or may slip out from between the tibia and femur, or may even be doubled over. It subsequently becomes inflamed and swollen, and unless properly treated the displacement is likely to be repeated.

The **Symptoms** produced by this accident are a sudden sickening pain of much severity, located in the knee, which becomes partially locked in a position of flexion, with inability to extend it. The patient may be able to 'wriggle' his joint free, or the limb may remain stiff for some hours, or even a day or two, when movement suddenly returns more or less spontaneously, a snap being at the same time felt within the joint. An attack of subacute synovitis usually follows. In other cases the cartilage remains out of place, until reduced by the surgeon, with or without an anæsthetic. If the case is not carefully treated, the displacement is liable to recur, the cartilage constantly slipping in and out, and getting nipped between the bones, as time goes on, this becomes more and more easy, owing to the ligaments of the joint being relaxed from the recurrent attacks of synovitis. In fact, the limb may pass into such a state of chronic weakness as to interfere seriously with the patient's comfort. There is usually a spot of localized pain in the front of the joint, corresponding to the upper surface of the tibia, possibly there may be some amount of lateral mobility of the leg, and movement of the cartilage may be detected on flexing and extending the knee.

The **Treatment** in the early stages consists in replacement of the cartilage by manipulation. The limb is fully flexed and then suddenly extended, pressure being applied at the same time in the neighbourhood of the displaced cartilage, which often returns into position with a distinct snap. The limb is subsequently kept at rest on a back splint, and cooling lotions are applied until the inflammation has subsided, it is then further immobilized for some weeks in plaster of Paris or water-glass, so as to allow the lacerated ligaments to re-unite and consolidate. At the expiration of six or eight weeks after the accident an elastic knee-cap is applied, and the patient again allowed to move the joint.

When the cartilage has become loose and is constantly slipping out of place, immobilization of the limb, with pressure over the painful spot by an elastic knee clip, as recommended by Mr Howard Marsh, or by Hawksley's knee truss (Fig 232), may be useful. Should this not prove satisfactory, operative proceedings must be undertaken.

The knee-joint is opened by an incision on the appropriate side of the patella, more or less transverse in direction, and the condition of the cartilage ascertained. If of normal shape and merely loose and

moveable, it may be readily stitched to the periosteum over the head of the tibia, so as to keep it from again slipping between the bones, this is perhaps best accomplished by splitting the cartilage diagonally into two portions, and securing each of these by two or three catgut stitches. If, however, it is doubled on itself, or deformed, or if fixation seems impracticable, it may be removed, it is astonishing how well patients get on after such an operation.

The greatest care must be taken to maintain asepsis, and no strong or irritating antiseptic should be allowed access to the joint cavity, which is closed by a series of buried sutures, dealing in order with the synovial membrane, the capsule, the superjacent tendinous tissues, and, finally, the skin. It is advisable to drain the joint for twenty-four hours, and, as an additional precaution against infection, it may be well to immunize the patient by preparatory injections of antistreptococcic serum.

**Rupture of the Crucial Ligaments** is another form of internal derangement, resulting from great violence. The integrity and strength of the joint are much impaired, and abnormal lateral and antero-posterior movements are possible. Should the condition persist, the joint may be freely opened, and the ligaments sutured.\*

**Dislocations of the Ankle-joint** may occur in the following directions—*outwards, inwards, backwards, forwards, and upwards*, this being the order of their frequency. Owing to the fact that the astragalus is wedged like a block into the mortice formed by the lower ends of the tibia and fibula, it is obvious that fractures of these bones are frequently met with as complications.

The lateral dislocations are in reality fracture-dislocations, and have been already described in the chapter on fractures (p. 559).

Although the upper articular surface of the astragalus is broader in front than behind, dislocation of the foot *backwards* is a more common accident than displacement forwards. It results from falls on the feet while running or jumping, or by sudden violence applied to the limb when the foot is fixed. Usually both malleoli are fractured, and the articular surface of the astragalus is thrown behind the lower end of the tibia. The heel projects unduly backwards, and the lower end of the tibia usually rests upon the neck of the astragalus, the scaphoid, or even the cuneiform bones.

Dislocation *forwards* is very uncommon, and may occur without any associated fracture of the bones of the leg. The foot is apparently lengthened, and the tibia rests upon the posterior part of the upper surface of the os calcis, behind the astragalus. The prominence

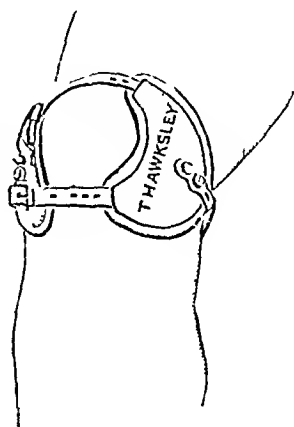


FIG. 232.—KNEE TRUSS FOR DISLOCATED INTERNAL OR EXTERNAL SEMILUNAR CARTILAGE, OR FOR CHRONIC DISLOCATIONS OF THE PATELLA.

\* Mayo Robson, *Annals of Surgery*, May, 1903.



of the heel and of the tendo Achillis is lost, and the normal depression in front of the latter structure is occupied by the lower ends of the bones of the leg

The *treatment* of antero-posterior dislocations consists in reduction by traction. The leg is flexed upon the thigh, so as to relax the tendo Achillis, or, if necessary, this structure is divided. The ankle is commanded by a pair of Cline's side-splints, care being taken to ascertain that the foot is at right angles to the leg, and that the articular surfaces of the astragalus and tibia are exactly in apposition, thus preventing any displacement of the heel backwards or forwards. A Roughton's splint—*i e*, an external splint with a sole-piece—is sometimes useful

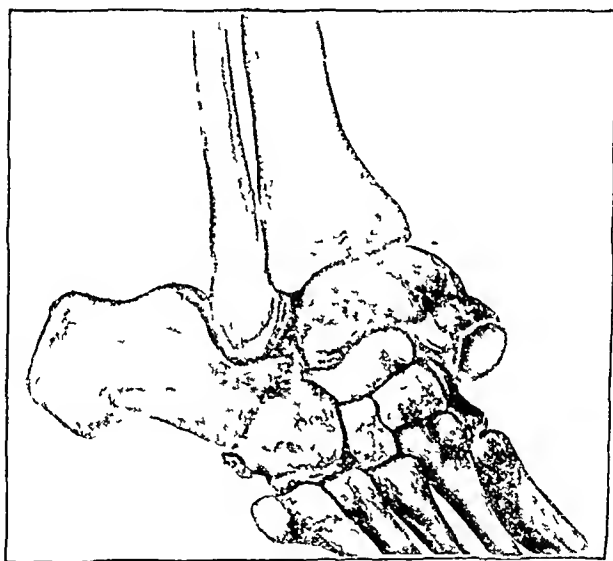


FIG 233 --DISLOCATION OF THE ASTRAGALUS FORWARDS

A dislocation upwards has been described in which the astragalus, together with the foot, is carried up between the tibia and fibula. To allow of such, the inferior tibio-fibular ligament and the lower end of the interosseous ligament must have been ruptured. Impracticable as such an accident appears, competent observers maintain that they have met with it. The displacement is very marked, and the character of the lesion very evident.

Dislocations of the Astragalus alone are by no means common, although their distinguishing features are well recognised. They consist in a partial or complete detachment of the bone from all its normal connections, both to the bones of the leg and of the foot, and its displacement from under the tibio fibular arch. It may travel backwards or forwards with or without lateral rotation.

Dislocation forwards (Fig 233) is much the more common variety, although it is usually associated with partial rotation, the displace-

ment occurring more frequently outwards than inwards. When complete, the bone is entirely detached from its connections with the os calcis, scaphoid, and bones of the leg, and lies upon the upper surface of the scaphoid and cuneiform bones, the skin of the dorsum of the foot being tightly stretched over it, or even torn. The limb is shortened, and the malleoli are approximated to the sole, the lower end of the tibia resting on the upper surface of the os calcis.

In the incomplete variety, the head of the astragalus impinges either upon the scaphoid on the inner side, or the cuboid on the outer, whilst the lower end of the tibia rests on the posterior half of the articular surface of the astragalus.

Dislocation backwards is almost always complete, and may or may not be associated with rotation of the bone, which can easily be felt between the tendo Achillis and the malleoli.

**Treatment**—Reduction is only possible in the incomplete forms of dislocation. The patient is anesthetized, the knee flexed to relax the muscles or the tendo Achillis divided, and traction upon the foot established, so as to enable the surgeon to apply pressure upon the displaced bone in a suitable direction. In the complete variety reduction is impracticable, owing to the fact that the os calcis is drawn up into contact with the malleolar arch. In such cases manipulation is useless, and excision of the bone is necessary. Comparatively little impairment in the function of the foot results from this operation.

**Subastragaloid Dislocation**—By this term is meant a displacement of all the bones of the foot from below the astragalus, which retains its normal position between the malleoli. The interosseous and other ligaments passing from the malleoli and astragalus to the other tarsal bones are necessarily ruptured. The cause of this, as of other dislocations in the neighbourhood, is some violent strain or wrench of the foot.

Displacement of the foot may occur either forwards or backwards, but in the great majority of cases it is either *backwards and inwards* or *backwards and outwards*. The luxation is rarely complete as regards the calcaneo astragaloid joint, but the articular surfaces of the head of the astragalus and scaphoid are completely separated, the former structure lying on the dorsal surface of the latter bone. The foot is greatly deformed, the anterior portion being shortened, the heel projecting, and the toes pointing downwards. The head of the astragalus is very evident, forming a rounded globular swelling under the tense skin. In a compound dislocation of this nature which we recently examined, *post-mortem*, the inner edge of the under surface of the astragalus had burst through the skin, the vessels and nerves were torn or stretched, and even when the wound in the skin had been enlarged, reduction was impossible owing to the tendons which had become caught around the neck of the astragalus. In such a case removal of the astragalus would have been the only practicable treatment.

In the inward displacements, the foot is somewhat inverted, so that the outer malleolus is unduly prominent, and the inner malleolus

is lost in a deep depression caused by the lateral displacement of the os calcis, the foot is thus in a position somewhat simulating talipes equino-varus. In the **outward** dislocations the foot is everted, the inner malleolus prominent, and the outer buried, a position of talipes equino-valgus being thus assumed. In both forms the tendo Achillis is curved, with its concavity towards the displacement. *Treatment* consists in reduction by manipulation, which is sometimes readily accomplished, but may be a matter of the greatest difficulty, probably from the tibial tendons becoming hitched around the neck of the astragalus. Section of the tendo Achillis is occasionally needed.

## CHAPTER XXII

### DISEASES OF JOINTS

#### Acute Synovitis

By **Synovitis** is meant an inflammation limited almost entirely to the synovial membrane, the ligaments and other structures of the joint being usually but little affected

The **Causes** are local and general. Local conditions include cold and injury, general or constitutional comprise rheumatism, gout, syphilis, pyæmia, and gonorrhœa

**Pathological Anatomy**—Acute synovitis results in hyperæmia of the synovial membrane, and exudation of plasma and leucocytes, firstly into the substance of the membrane, causing it to be thickened and spongy, and subsequently into the joint, the endothelium also proliferates, and is shed. In the early stages the effusion consists of synovia, diluted with blood plasma, and often discoloured with blood in traumatic cases, and hence on removal is spontaneously coagulable, after a time the plasma may coagulate, depositing lymph upon the articular surface, whilst serum remains. The lymph thus deposited may either be removed by a natural process of absorption when the inflammation comes to an end, or it may organize, so as to form adhesions. In the later stages the synovial membrane becomes somewhat thickened, and the ligaments possibly a little infiltrated and relaxed

The **Clinical Signs** of acute synovitis consist in the joint becoming painful and distended, whilst if the articulation is superficial, as in the knee, a sense of heat may be imparted to the hand, and the surface may even be red and hyperæmic. The limb is maintained by muscular spasm in that position which gives the most ease, viz, that in which its capacity is the greatest, and this is usually one of slight flexion, but if the condition is neglected, the flexion may increase considerably, the muscles undergoing tonic contraction, and the limb remaining more or less fixed in an undesirable position. The muscles governing the movements of the joint occasionally undergo rapid atrophy, probably resulting from a reflex disturbance of their trophic centres in the cord

**Evidence of Effusion into Various Joints**—*Shoulder* The curvature of the shoulder is increased, and the deltoid expanded by a fluid swelling beneath it, which is especially noticeable at its anterior border along the bicipital groove, and sometimes posteriorly, in the

axilla a painful intumescence may also be felt. These symptoms may be somewhat simulated by inflammation of the multilocular sub-deltoid bursa, but the latter condition is recognised by the absence of any axillary swelling, by its not encroaching on the anterior and posterior borders of the deltoid, and by the fact that, although when the patient voluntarily moves his arm pain is produced, yet when the surgeon gently manipulates it, so as to press the head of the bone against the glenoid cavity, there may be none.

*Elbow* The hollows on either side of the olecranon and tendon of the triceps are replaced by soft fluid swellings, the outer of which also extends down to, and masks, the head of the radius, there is usually a little general puffiness in front of the joint. It is readily distinguished from inflammation of the olecranon bursa by the fact that in the latter condition there is a central fluid prominence over the bone, whilst in the former the swellings are placed on either side of and above the bony projection.

*Wrist* There is a general fulness both on the anterior and posterior aspects of the joint, whilst fluctuation may be detected beneath the dorsal tendons, which are slightly separated and displaced. It is distinguished from synovitis of the superjacent tendon sheaths by the fact of its strict limitation to the neighbourhood of the joint, and the absence of the superficial crepitus, so characteristic of the latter condition.

Effusion into the *Hip-joint* cannot be easily detected by digital examination. There may be a little fulness and tenderness in the gluteal region, or in the upper and outer part of Scarpa's triangle. The most characteristic feature, however, is the position of flexion, abduction, and eversion taken by the limb, whilst limitation of movement is equally marked.

The *Knee*, when distended with fluid, presents a rounded outline, in which all the normal hollows, especially those on either side of the patella and ligamentum patellæ, have disappeared. There is also a swelling corresponding to the subcrural pouch, more marked on the inner than the outer side, and extending for 3 or 4 inches above the patella. Fluctuation can be readily detected when one hand is placed above the patella, and the fingers of the other hand compress the tissues on either side of the ligamentum patellæ below, or by alternate pressure on either side of the rectus tendon. When the effusion is considerable, the patella is felt to float, and on pressing it sharply backwards can be made to tap against the intercondylar notch of the femur (*patellar tap*). A smaller effusion is recognised by pressing the fluid downwards from the subcrural pouch with the knee fully extended, when the patellar tap can usually be demonstrated. Enlargement of the bursa patellæ is recognised by the swelling being central and in front of the patella, so that its outline is obscured.

*Ankle* The hollows between the tendo Achillis and the malleoli are replaced by fluctuating swellings, whilst the dorsal tendons are displaced forwards, and a fluid swelling appears in front of each malleolus. Enlargement of the bursa beneath the tendo Achillis is so obviously confined to the back of the joint that it should never be mistaken for true synovitis of the ankle.

When the acute stage has passed, the joint is usually left in a

somewhat weak and relaxed condition, with a little passive effusion, or perhaps some adhesions. The *adhesions* which follow acute synovitis are usually slight in character, if the case has been properly treated, they result from the union of patches of lymph on opposing surfaces of synovial membrane or bone, which become organized into loose fibro-cicatrical tissue, containing a few delicate bloodvessels, and covered by endothelium extending over them from the adjacent serous membrane. The characteristic signs of such a condition are painful limitation of movement in some particular direction, and possibly a little soft crepitus.

The **Treatment** of acute synovitis consists in so immobilizing the joint as to give the patient the greatest amount of ease, whilst, should ankylosis result, the limb is left in as favourable a position as possible for subsequent utility. Thus, the *shoulder* should be bandaged to the side, and the hand kept in a sling, the *elbow* is placed on an internal angular splint, and flexed to a little more than a right angle, whilst the hand is midway between pronation and supination, for the *wrist* all that is needed is to apply a palmar splint to the fore-arm, the *hip* is immobilized by the application either of a Thomas's splint or of a Liston's long splint, or by placing the limb between sand bags and adjusting an extension apparatus, the *knee* is put on a back splint, perhaps slightly flexed, whilst the *ankle* is best kept at rest by applying what is known as a Roughton's splint, i.e., an external splint with a foot-piece. Necessarily, in all severe cases of acute synovitis the patient should be confined to bed and the limb elevated. If the case has been neglected and the limb has assumed a vicious position, the patient should be anesthetized and the malposition corrected, or gradual extension is made by means of a weight and pulley, until the correct position is attained. In the early stages cold should be applied to the joint by means of evaporating lotion, an icebag or Leiter's tubes, but this is not advisable in old people. In the later stages fomentations give greater relief, whilst the application of a few leeches may also be beneficial. When the distension is considerable, removal of some of the fluid by a carefully purified aspirator, or trocar and cannula, may diminish pain and hasten recovery.

In the subacute stage, when the joint is weak and relaxed, massage or friction with stimulating liniments should be employed, whilst in the more chronic forms firm pressure, and preferably by means of a Martin's bandage, is most useful as an additional measure.

If adhesions are present, they should be carefully broken down under chloroform, the limb is subsequently kept at rest for a few days upon a splint, whilst passive movements and massage are afterwards adopted.

### Chronic Synovitis

This affection follows an acute attack, or may be lighted up by some injury or condition insufficient to determine a more violent form of inflammation. The synovial membrane becomes thick and infiltrated, whilst the effusion is sometimes relatively less than in the

acute form, sometimes excessive, then constituting the condition described as *chronic serous synovitis* (Fig 234), a phenomenon often seen affecting the knees after rising from a prolonged stay in bed

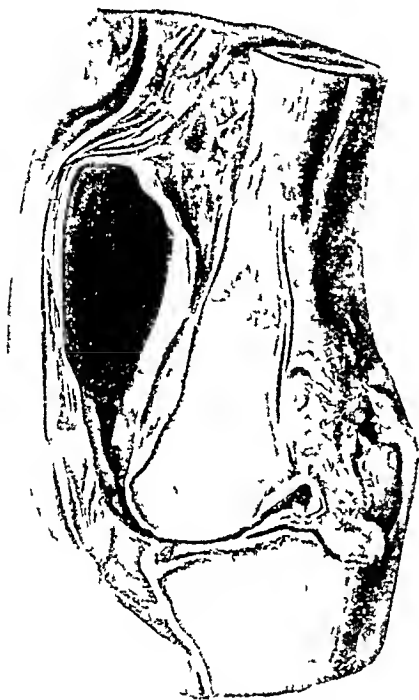


FIG 234 —CHRONIC SEROUS SYNOVITIS OF KNEE, WITH DISTENSION OF THE SUBCRUREAL POUCH (FROM COLLEGE OF SURGEONS' MUSEUM)

The pain is usually not severe, being replaced by a sense of uselessness and weakness. It is interesting to note that, in cases where the effusion is well marked, the bursa communicating with the joint frequently become distended, they are prevented from participating in the acute forms of inflammation by the fact that the apertures of communication with the interior of the joint are narrow and slit-like, and thus readily become occluded by the swelling of the membrane. Crepitus is sometimes met with in chronic synovitis, possibly from a roughening of the articular surfaces on which lymph has been deposited, or between which fibrous adhesions have formed.

Occasionally the synovial fringes become hypertrophied, giving rise to a condition similar to that described under osteo-arthritis (p 672). The overgrown villi usually spring from the reflections of the synovial membrane close to the bone, and may be loaded with

fat, constituting the condition known as 'Lipoma arborescens'. In the knee-joint the fringes may be felt rolling under the fingers, and painful symptoms may be caused by the loose ends being caught and nipped between the bones.

**Treatment** consists in fixing the joint in a suitable position, and applying counter-irritation and pressure, Scott's dressing and blisters are especially useful in this affection. At a somewhat later stage elastic pressure by a Martin's bandage may be employed, together with friction with stimulating liniments, or even hot-air baths. Removal of some of the fluid by aspiration and subsequent compression may also do good, but if the affection resists such treatment, the best procedure consists in opening the joint, washing it out with sterile saline solution, and draining it for a few days.

Should enlarged villi be present and give rise to trouble, the joint should be opened, and if they are limited in their distribution they may be clipped away, or the synovial membrane from which they grow dissected out. When very extensive, so that removal would

involve total excision of the synovial membrane and consequent stiffness, it may be wise to wash out and drain, in the hope that they may become fixed, before undertaking complete extirpation of the membrane

**Hydrarthrosis (Hydrops Articul)** is the term applied to any condition of a chronic nature in which the joint is much distended with fluid. It may arise from at least five different affections (a) Chronic serous synovitis, (b) in osteo-arthritis, a very common cause, (c) in Charcot's disease, (d) in secondary syphilitic synovitis, and (e) occasionally in tuberculous disease. It must be remembered that it is but a symptom, and not a disease *suu generis*, and treatment necessarily varies with the cause

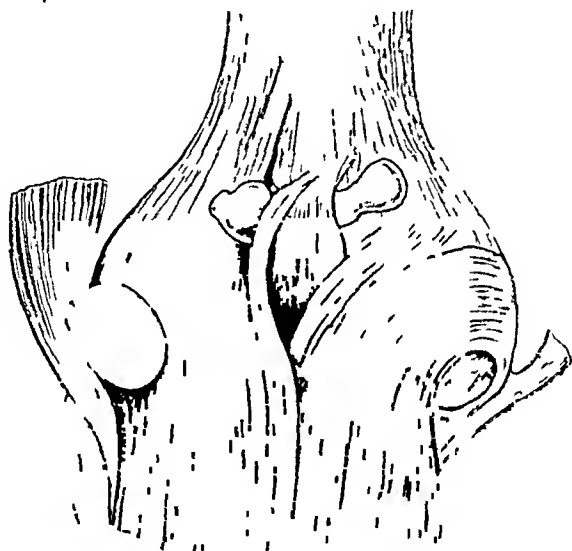


FIG 235 —BAKER'S CYSTS FROM BACK OF KNEE (HOWARD MARSH)

**Baker's Cysts** —This condition, first described by the late Mr Morrant Baker, consists in a hernial protrusion of the synovial membrane of a joint through an aperture in its fibrous capsule (Fig 235). It is usually due to some chronic affection of the articulation, especially osteo-arthritis or tuberculous disease, whereby the intra-articular pressure is increased, and not uncommonly several such sacs are connected with the same joint. They vary much in size, contain synovial fluid, and, though at first communicating with the joint cavity, have a tendency to travel away from it, burrowing along muscular and fascial planes, and coming, perhaps, to the surface some distance from their origin, the aperture of communication with the joint having in some instances been shut off. If causing no troublesome symptoms, there is no necessity to interfere, but if they become inconvenient or painful, it is easy to dissect them out, closing where necessary by ligature or suture the narrow neck which



leads into the joint. Of course, the strictest asepsis must be maintained in all such proceedings, and the causative affection must not be forgotten.

### Acute Arthritis

By the term **Arthritis** is meant any inflammation of a joint which involves all the structures of which it is composed, viz, bones, ligaments, cartilages, and synovial membrane.

**Causation**—Acute arthritis is practically always due to infection of the joint cavity with bacteria, which reach it either from within or without the body. (i) It may be due to the entrance of cocci through a punctured or valvular wound of the joint, or during operations. It is interesting to note how extremely prone to inflammation is the synovial membrane when opened, even after the most careful antiseptic precautions. The micro-organism most commonly present is a modification of the *Streptococcus pyogenes*, but various other pathogenic organisms have also been found in special cases. (ii) It may arise in a manner exactly analogous to that in which acute infective osteo-myelitis is produced—i.e., the patient is in a low state of health, his natural germicidal powers are diminished, pyogenic organisms are present in the blood-stream, gaining access through some breach of surface, and, finally attacking any weak or damaged tissue, produce therein suppurative inflammation. A slight injury, e.g., a sprain or strain occurring in a weakly child, convalescent from measles or scarlet-fever, may result in this affection. (iii) It may be produced by the lodgment of a pyæmic embolus, and in a similar way it not unfrequently follows as a sequela of fevers, such as enteric or pneumonia, by direct transmission of some infective material. (iv) It is sometimes met with as a result of gonorrhœa, and may then run its course with or without suppuration. (v) It may be lighted up as a result of the extension of inflammation from the end of a neighbouring bone, or from the bursting of a subcutaneous or bursal abscess into the joint. Acute arthritis of the hip joint is commonly due to the former of these conditions, being consecutive to an acute infective osteo-myelitis of the upper end of the femur. (vi) It is occasionally observed as a result of rheumatism, the inflammation running a very acute course, and leading to disorganization of the joint, though without suppuration. Such attacks are undoubtedly bacterial in origin.

**Course of the Case**—In the early stages acute arthritis manifests itself as a hyperacute synovitis, combined with severe pain and fever. The pain is often so intense that the patient cannot bear the part to be touched or the bed shaken, and indeed the slightest jar of the limb is so exquisitely painful that the patient may scream with agony. The joint itself is distended with a turbid effusion, which rapidly becomes purulent, and the tissues around are hyperæmic and œdematous. The patient naturally places himself in that position in which the limb obtains the greatest ease, and therefore usually semiflexes the joint and fixes it by muscular contraction.

As the disease progresses, pus is formed within the capsule, bursting through it, and either travelling directly to the surface, or burrowing deeply into the substance of the limb, thus, in the knee an enormous abscess may collect beneath the vasti muscles, stripping them from the bone for a considerable distance. The pain increases whilst the abscesses are forming, and becomes especially distressing at night, the patient being often waked by a painful start just as he has fallen asleep. This condition usually indicates that the articular cartilages are becoming affected, and is explained by the fact that, just as the patient loses consciousness, the muscles which fix the joint are relaxed, and allow the inflamed surfaces to shift their position slightly, exciting severe pain and a sudden spasmodic contraction of the muscles. Gradually the deformity becomes more and more obvious, whilst the infiltration and relaxation of the ligaments sometimes allow of abnormal movements, *e g*, of lateral mobility in the knee-joint, the ends of the bones become carious, and absolute displacement or dislocation may follow. Sinuses may open in all directions, and the patient suffer from recurrent rigors, caused by toxæmia or the onset of pyæmia. The constitutional effects are always severe, consisting of high fever, and rapid exhaustion from the pain, sleeplessness, and absorption of toxins.

The *terminations* of this affection are as follow (a) Recovery, rarely with a moveable joint, and then only after active interference, in most cases ankylosis in a good or bad position, according to the treatment, is the best result that can be expected. (b) During the acute stage the patient may die of pyæmia, or acute toxæmia and exhaustion. (c) If he survive the acute stage, chronic suppuration may ensue, and symptoms of hectic and amyloid degeneration in the viscera may supervene. In such cases sinuses leading down to carious bones exist, and, unless efficient measures are taken to obtain asepsis, or to remove the diseased structures, perhaps by amputation, the patient is likely to die from exhaustion or chronic sapræmia.

**Pathological Anatomy**—The *synovial membrane*, at first merely infiltrated and hyperæmic, soon becomes converted into granulation tissue from within outwards, exuding abundant pus. The *ligaments* in turn are sodden and relaxed by the presence of a plastic exudation between the fibres, rendering them soft and œdematous, so that the tonic contraction of the muscles easily stretches them and brings about displacement.

The *articular cartilages* are disintegrated and destroyed in various ways, according to the acuteness of the inflammation and the amount of pressure to which they are exposed. In acute cases they early lose their normal bluish-white appearance, and become opaque and slightly yellow. The central parts, which are exposed to pressure between the ends of the bones, soon disappear, whilst the peripheral portions are eroded by the growth of the granulation tissue developing from the synovial membrane. When once the cartilage has been perforated at any one spot, the suppurative inflammation spreads along its under surface, stripping it from the bone, and thus inducing

necrosis, as a result of which isolated portions of dead cartilage may be found lying in the joint. In the more chronic forms of the disease, proliferation of the cartilage cells occurs, whereby the capsules become distended, and the matrix encroached upon, some of these cavities burst into the joint, and leave more or less flask-shaped openings into which pyogenic organisms find their way, thus aggravating the mischief, others nearer the deep aspect of the

cartilage become transformed into granulation tissue by vascularization from the vessels in the bone. In these ways the cartilage is destroyed or replaced by granulation tissue, a proceeding analogous to ulceration of the softer parts. The *interarticular cartilages* are affected in a very similar manner, and quickly disappear.

The *ends of the bone* pass into a condition of acute osteitis, resulting in the transformation of the medulla into granulation tissue, absorption of the bony cancelli with or without suppuration, and sometimes necrosis of small portions of the cancellous tissue (*caries necrotica*). The veins within the cancelli become thrombosed, and hence pyæmia may result. The *periosteum* covering the ends of the bones is also inflamed and hyperæmic, in consequence of which spiculated or stalactiform osteophytes are produced (Fig 236). The *muscles* in the neighbourhood of the joint undergo rapid atrophy and fatty degeneration, probably as a result of some reflex disturbance of the trophic centres.

**Treatment**—In the early stages the limb must be elevated, absolutely immobilized, and put into such a position that, if ankylosis subsequently obtains, it may be of some use to the patient. Fomentations or an icebag may be applied temporarily, but as soon as the symptoms point to suppuration, the joint should be freely opened in one or two places, washed out with some sterile or antiseptic solution, and drainage-tubes inserted, whilst necessarily any peri-articular abscesses are dealt with in the same way. Openings should preferably be made on opposite sides of the joint, so as to allow the cavity to be flushed out frequently, or, if con-

sidered desirable, for continuous irrigation of the joint with some mild antiseptic (e.g., weak boracic lotion, or sublimate solution, 1 in 8,000), or some bland unirritating fluid, such as sterilized normal saline solution. The fixation of the limb is maintained, and the general health attended to. Irrigation should be continued until all signs of inflammation, pain, heat, and startings of the limb have

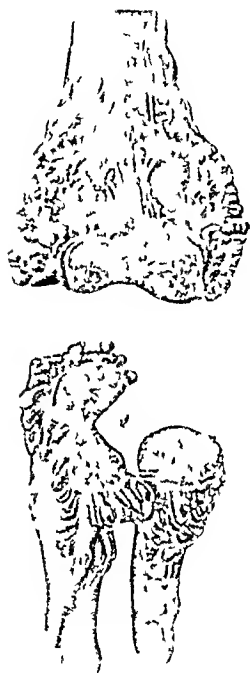


FIG 236—ENDS OF THE BONES AFTER ACUTE ARTHRITIS OF ELBOW SHOWING THE CARIOUS SURFACES DEVOID OF CARTILAGE, AND THE DEVELOPMENT OF STALACTIFORM OSTEOPHYTES (FROM KING'S COLLEGE HOSPITAL MUSEUM)

passed away Under such a régime it is sometimes possible to obtain a moveable joint, but more frequently ankylosis must be expected Excision may be required in order to prevent or remedy faulty ankylosis, or to place the limb in a good position, it is also undertaken in some cases of chronic suppuration, with caries of the ends of the bones and displacement, but, as a rule, not until all acute symptoms have passed away If the patient is suffering from severe toxæmic or pyæmic symptoms threatening life, amputation may be required, as also for exhaustion from long-standing suppuration and hectic fever

### *Acute Arthritis of Special Joints*

In the **Shoulder**, infection sometimes occurs through the axilla where the capsule is weak and easily invaded by organisms, as after an axillary cellulitis, more frequently it follows a penetrating injury Severe pain is caused by any movement of the arm affecting the joint, and the pus in the distended synovial membrane comes to the surface in front of or behind the deltoid or in the axilla It may suffice to open the articulation anteriorly and flush it out, but, if possible, a counter-opening should be made behind by cutting down on a pair of dressing-forceps pushed backwards through the capsule In many instances the patient's condition will not improve until the head of the bone has been excised The subsequent results as regards movement and power of the arm are, on the whole, very satisfactory

In the **Elbow**, there are no points requiring special mention as to clinical history or results, although it must be remembered that the superior radio-ulnar articulation is necessarily involved, and hence the power of pronation and supination of the hand is threatened As to treatment, incisions should be made on either side of the olecranon, the ulnar nerve being avoided The limb is then placed on a rectangular splint, and with the hand midway between pronation and supination, of course, the patient is kept in bed, with the arm raised on a pillow In an adult excision may be undertaken as soon as the acute stage has passed, in order to obtain a moveable elbow, but in children, where the growth is incomplete, it is better to allow ankylosis to occur, and excise, if need be, at a later date

The **Wrist** may be infected secondarily to septic conditions following operations on ganglia in the neighbourhood, or through direct injury The essential treatment consists in free incisions parallel with the tendons, and avoiding the sheaths Ankylosis usually results, and excision is not resorted to except when the disease has become very chronic, with extensive caries of the carpus

Acute arthritis of the **Hip-joint** is usually a sequela of acute infective osteo myelitis attacking the upper end of the shaft of the femur, and involving the joint, owing to the epiphyseal cartilage being intra-capsular, it also results from pyæmia, and rarely from penetrating injuries The symptoms are similar to those of the first stage of ordinary tuberculous disease (p 686), but much more acute There is high fever, together with intense pain, marked flexion and eversion

of the limb, early suppuration, and rapid disorganization if not properly treated, indeed, where nothing is done, and the patient lives long enough, the head of the bone may be entirely absorbed, or is detached, and remains as a sequestrum in the disintegrated articular cavity. As soon as the capsule gives way, the pus may come to the surface in any of the usual localities for hip-joint abscesses. In treating these cases, the joint should be freely laid open in the situation which appears most favourable. The anterior incision is more suitable for the early, and the posterior for the later, stages, when the head of the bone is either dislocated, or remains *in situ* and separated from the shaft. A double opening may sometimes be utilized with advantage.

The **Knee joint** is more frequently involved by this disease than any other, and is usually infected from without. The symptoms are exceedingly typical: the pain is very acute and the joint hot and distended to its utmost capacity, the limb lying semiflexed and on its outer side. Left to itself, the capsule gives way, and suppuration rapidly extends upwards beneath the vasti or downwards into the leg, the pus ultimately finding its way to the surface. The deformity gradually increases, until in the worst forms the tibia slips behind the condyles of the femur, the leg is flexed to a right angle and rotated outwards, and if the limb has long rested on its outer side, considerable lateral displacement may also occur. Early and efficient treatment will usually prevent such a disaster. The joint should be freely incised on each side of the patella, so as to open up the sub-crural pouch, and the whole articular cavity well washed out. In some cases a counter-opening may be made with advantage and a drain-tube inserted, by passing a pair of sinus forceps through the outer portion of the posterior ligament of Winslow, and cutting down on it to the inner side of the biceps tendon and clear of the external popliteal nerve. By this means more efficient drainage of the articular cavity is obtained.

When the **Ankle-joint** is involved, amputation has often to be resorted to, in consequence of the difficulty of securing good drainage, although excision of the astragalus will sometimes cut short the disease and lead to a good result.

### *Special Forms of Synovitis and Arthritis*

**Rheumatic Synovitis** is met with in the course of acute rheumatism, or as a chronic affection from the commencement. The former is recognised by the presence of fever, acid sweats, high-coloured urine loaded with lithates, and a tendency to metastasis, one joint after another being involved, complete resolution usually follows, but there may be some thickening of ligaments and consequent impairment of mobility. If the disease is limited to one joint, absolute disorganization, though without suppuration, may ensue (acute rheumatic arthritis). There can now be little question that this disease is of bacterial origin and due to a diplococcus (Poynton, Paine).

The chronic variety is characterized by swelling of the joints, due partly to effusion, partly to thickening of the synovial membrane and

of the capsular and other ligaments. If neglected, it may produce fixity of the joint, due mainly to ligamentous changes, but also resulting from the development of intra articular adhesions, but there is never any lipping of the cartilages or new formation of bone, as in osteo-arthritis. Not unfrequently other evidences of rheumatism may be present, such as chorea, erythema, etc., whilst rheumatic nodules (*i.e.*, new growths of fibrous tissue beneath the skin, perhaps reaching the size of a walnut, but more often much smaller) may also develop.

The **Treatment** of the acute form is medical rather than surgical, and general rather than local. The affected joints must be kept at rest in good position, and wrapped in warm cotton-wool, or, perhaps better, soda fomentations may be applied. Should the inflammation resist such measures, it is quite justifiable to open and wash out the joint, which is found to be occupied by a greenish, semi-puriform effusion.

In the more chronic forms anti-rheumatic drugs have less power, and more attention must be paid to diet. Butcher's meat, sweets, and rich dishes should be avoided, and as far as possible a 'white diet' obtained. Mineral waters are exceedingly valuable, and a visit to a suitable home or Continental spa may be desirable. Locally, massage and stimulating embrocations do good, but in bad cases counter-irritation by repeated blisters, or even by applying the actual cautery, is desirable. Malposition may be corrected under an anæsthetic or by weight extension. Localized hot-air baths (Sheffield-Tallerman system, or Dowsing's radiant electric heat) do good in some cases.

**Gouty Arthritis** is characterized by certain well-marked features. It often attacks the metatarso-phalangeal articulation of the great toe (podagra), or the metacarpo-phalangeal joint of the thumb (cheiragra). Its onset is usually sudden, and it frequently commences in the middle of the night. The tissues around the joint become swollen, red, shiny, and œdematous, whilst the superficial veins are prominent. The attack is exceedingly painful, and the skin exquisitely tender. These symptoms pass off in the course of a few days, leaving the articulation swollen and sensitive.

Even a single attack results in a slight deposit of bi-urate of soda in acicular crystals in the matrix of the articular cartilage close to the surface, but when the joint has been several times inflamed, the whole thickness of the cartilage may be invaded by this chalky deposit, whilst the ligaments and ends of the bones are also infiltrated. In the smaller joints it may increase to such an extent as to form well-marked swellings, or 'tophi,' similar in character to those so commonly seen in the external ear. The skin sometimes gives way over these, and a chalky discharge results. In some cases the cartilages

\* Dr Bunnatynes opinion as to the diagnostic value of fibrous or bony subcutaneous nodules connected with articular lesions is as follows: 'Muscular swellings are most often due to rheumatism, small subcutaneous nodules also to rheumatism, larger ones to rheumatoid arthritis, bursal enlargements to chronic gout, rheumatoid arthritis, or rheumatism, and bony nodes (of the Heberden type) to chronic gout or chronic rheumatoid arthritis.'

are eroded, and eburnation of the exposed bone may follow, as in osteo-arthritis. The *treatment* of acute gout consists in fomenting the parts or applying glycerine of belladonna, whilst colchicum, citrate of lithia, and alkaline purgatives are administered. In the more chronic forms iodide of potassium may be given, and the diet and drink are carefully regulated. Probably some form of hydrotherapeutic treatment will be required, and if the patient cannot go to a suitable spa much may be done at home by getting him to drink a large cup of hot water half an hour before each meal.

**Pyæmic Synovitis** is due to embolic infection from some suppurating focus. The joint becomes rapidly distended with pus, and often without pain. If the joint is promptly opened, washed out and drained, its disorganization may be in many cases prevented (*vide* Pyæmia, p. 83), otherwise destructive changes will quickly follow.

**Typhoid Disease of Joints**—1 A *simple chronic synovitis* occurs in one or more joints, with but slight effusion and little inflammatory disturbance. It is somewhat resistant to treatment, and hence may cause limitation of movement. Possibly it is due to the action of toxins rather than of the living organism. 2 The *true typhoid arthritis*, due to the *B. typhosus*, is characterized by a marked inflammatory effusion into one or more joints, and is liable to end in spontaneous dislocation, especially in the hip-joint. Suppuration, however, is rare, and the prognosis favourable, provided the limb is kept in a good position. The presence of a large effusion indicates aspiration. 3 A *mixed pyogenic and typhoid* infection results in active suppuration within the joints, the *B. typhosus* playing quite a subsidiary part. 4 A *pure pyogenic* infection. In these latter two varieties the ordinary symptoms of acute suppurative arthritis occur, and the treatment for that affection must be instituted.

**Pneumococcal Arthritis**—In the course of an acute pneumonia the pneumococcus is occasionally disseminated through the body, and is then very likely to attack a joint which has been already damaged, giving rise to a suppurative arthritis with an effusion of thick creamy pus, or sometimes to a milder form of synovitis. Males are more often affected than females, and the upper rather than the lower extremity. Occasionally more than one joint is involved, and, with the exception of the hip, the larger joints are attacked rather than the smaller. There are no special peculiarities in the disease, but since it is merely part of a general infection, a high mortality is associated with it. Suppuration usually occurs, and its onset is always an indication for incising, washing out, and draining the joint.

It may also occur primarily and apart from any other obvious pneumococcal lesion. The symptoms are then those of a subacute arthritis with effusion, which may be so resistant to treatment as to require arthrotomy. Some limitation of movement is likely to follow.

**Gonorrhœal Disease of Joints** is always due to infection with the gonococcus, transmitted by the blood from the primary focus of mischief. Whilst usually seen in connection with gonorrhœal urethritis in males, it has been known to follow ophthalmia neonatorum, and has

been lighted up by passing a full sized bougie on a patient with gleet. It generally commences after the third week of the gonorrhœal attack, when the discharge is becoming subacute. It may involve one or many joints, the knee, ankle, and wrist being most frequently affected, and perhaps on both sides of the body. Two distinct types of trouble may manifest themselves, but they are not unfrequently combined. In one, the synovial membrane is mainly affected, and the effusion is chiefly intra-articular, so that the condition closely resembles an ordinary attack of acute traumatic synovitis. In the other, the peri-articular structures bear the brunt of the mischief, and there is at first but little effusion *in* the joint, but much around it, the parts even becoming œdematous, the ligaments are infiltrated and softened, so that displacement readily occurs, surrounding muscles atrophy rapidly, the patient suffers from severe pain and fever, so that he becomes thin and worn. In the worst cases the intra-articular effusion increases, and is sero-purulent, yellowish green in colour, and contains flakes of lymph, but it is never truly purulent. Both forms are very chronic and resistant to treatment, and hence ankylosis, with or without disorganization, is very liable to follow. Treatment is not very satisfactory. The urethral discharge must be arrested as soon as possible, whilst the affected joints are kept at rest, moderate pressure and counter-irritation, as by Scott's dressing, are perhaps the best means of dealing with the later stages in simple cases. Iodide of potassium, mercury, and quinine may be administered internally. Should the local phenomena be at all severe, the joint must be opened, irrigated, and drained, and if undertaken sufficiently early ankylosis may be prevented.

### Tuberculous Disease of Joints

**Tuberculous Arthritis** (*Syn Pulpary Degeneration of the Synovial Membrane, White Swelling, etc.*) may commence either in the synovial membrane or in the articular end of the adjacent bone (tuberculous epiphysitis, p. 591), or it may spread from the periosteum to the synovial membrane, as a result of a tuberculous periostitis, or from a neighbouring bursa. There is some slight difference of opinion as to the relative frequency of the synovial and osseous varieties, but the latest investigations certainly seem to indicate that in children the disease commences most frequently in the epiphyses, whilst in adults it may start either in membrane or bone with about equal frequency.

The Causes may be summed up as follows. The individual is predisposed to the development of tuberculous disease, usually as the result of an inherited tendency, a family history of tubercle being often obtainable, the general health of the patient may be at fault, owing to insufficient or inappropriate food, bad hygienic surroundings, or exposure to cold. Some slight injury of which but little notice is taken may lead to the actual deposit of the *B. tuberculosis*, which gains access to the body through some breach of surface, or even perhaps through a healthy mucous membrane. Severe articular lesions



such as dislocations, are much less likely to induce tuberculous disease, partly because their gravity demands efficient treatment, partly because the activity of the reparative process is capable of dealing with the organisms, even if they are brought to the spot

**Pathological Anatomy**—The *synovial membrane* becomes thickened, pulpy, and œdematous, and in the early stages, on naked-eye examination, may be found to be studded with small gelatinous nodules, about the size of a pin's head, situated immediately beneath the serous lining, later on, these may amalgamate into caseous masses, which burst and discharge into the joint, leaving ulcerated surfaces. Finally, the synovial membrane is changed into a so-called pyogenic membrane, consisting of granulation tissue similar to that lining the cavity of a chronic abscess, and more or less closely attached to the surrounding structures, which are transformed into œdematous fibro-cicatrical tissue, whilst the superficial parts undergo fatty or necrotic changes. Microscopically, one finds all the ordinary appearances of tuberculous disease, the vessels being in a state of endarteritis for some distance from the serous surface. Fringes of the synovial membrane, swollen and succulent, spread over the margins of the *articular cartilage*, and as they increase in size become adherent to it, just as, according to Billroth's classical description, ivy creeps along a wall. On lifting the edges of these fringes, the underlying cartilage is found hollowed out and eroded. As soon as the whole thickness is destroyed at any one spot, the cancellous tissue at the *end of the bone* becomes similarly affected, and the granulations spread along under the cartilage, cutting it off from its nutritive supply, and thus large flakes of necrosed cartilage may be shelled off, a process specially seen in the hip-joint. As a result of the hyperæmic condition of the end of the bone, especially when sepsis is superadded, a new formation of subperiosteal osteophytes, stalactitiform in character, sometimes takes place, but not to such an extent as in acute arthritis. Occasionally the periosteum itself is involved in the tuberculous process, and the disease may then extend some distance from the joint.

When the bone becomes involved, either primarily or secondarily, any of the manifestations of tuberculous disease described in Chapter XX may be met with, and thus it is not uncommon to find sequestra in connection with tuberculous arthritis. When it originates in the bone in adults, the tissue directly contiguous to the articular cartilage is often that primarily attacked, but in children it more frequently starts in connection with the epiphyseal cartilage. The joint is usually infected by extension of the disease through the articular cartilage, but when the synovial membrane extends along the bone beyond the cartilage, it may become involved without any cartilaginous lesion. In the early stages a simple synovial effusion may occur, but gives place to the more typical manifestations when infection has followed. Occasionally a tuberculous abscess bursts into a joint, acute symptoms supervene, but gradually quiet down, and the usual chronic phenomena subsequently develop. More commonly the infection is slow and gradual, and the

onset of the articular symptoms is of a similar character The extent of the mischief in the bones may sometimes be ascertained by the radiography (see Plates XXIX and XXX)

**Clinical History** — The disease usually commences in a most insidious manner It may be dated back to some injury, but as often as not no such occurrence has been noted Slight impairment of movement, together with some pain, especially when the limb is jarred or twisted, is perhaps the first sign, causing the patient to limp if one of the lower extremities is involved This limitation of movement is usually manifested in *all* directions, and this will often assist in diagnosing it from the fixity due to the presence of adhesions in a simple chronic synovitis The amount of rigidity varies much, in a purely synovial lesion the movements may at first be but little impaired and painless, although the whole region of the joint may be puffy and swollen, when, however, the bone is affected, either primarily or secondarily, the limitation of movement is considerably increased The position of the limb is that which will give the greatest amount of comfort, and varies in different joints (*q v*) On inspection a superficial joint, like the knee, looks white, smooth, and rounded, the swelling being more apparent on account of the wasting of adjacent muscles On palpation, the part is found to be hotter than that on the opposite side of the body, whilst fluctuation is not readily detected, there being but little fluid in the joint, though the affected tissues are elastic and puffy In a few rare cases, where the synovial membrane is widely involved, the affection commences with considerable serous exudation, giving rise to the condition known as tuberculous hydrops, after persisting for a while, the usual manifestations of the disease show themselves According to König

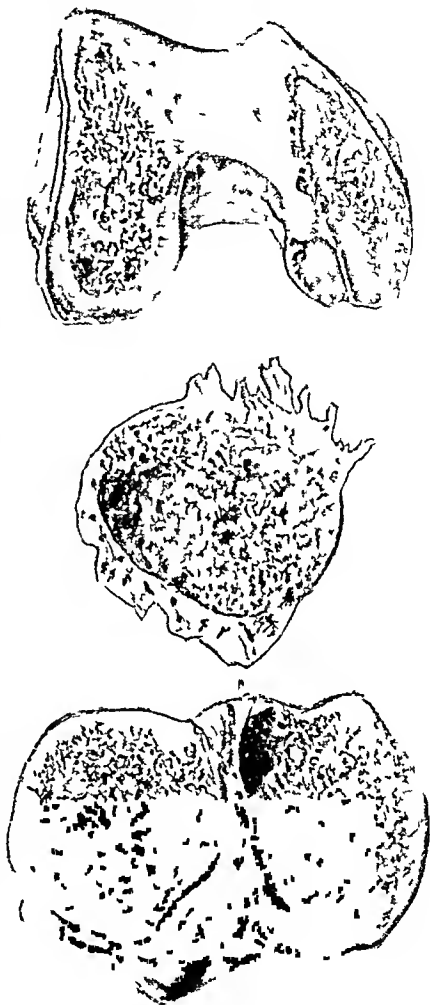


FIG 237 — BONES ENTERING INTO FORMATION OF KNEE-JOINT WHICH HAS BEEN DISORGANIZED BY TUBERCULOUS DISEASE (FROM COLLEGE OF SURGEONS' MUSEUM)

The cartilage is almost entirely destroyed, and the exposed bone is carious and eroded

a number of joints may be affected with hydrops in the first place, but all clear up except one, and that becomes tuberculous. In this type fibrinous melonseed bodies are occasionally found, and a cytological examination indicates an excess of lymphocytes in the exudation.

From time to time exacerbations of pain and increase of swelling occur, which subside after a few days, but leave the joint more and more crippled. Sooner or later abscesses are likely to develop, with increased local disturbance, and often starting pains at night, due to the erosion of cartilages, together with slight general fever and malaise. If they burst, temporary relief follows, but if the discharge continues, and fresh abscesses form, septic phenomena are usually added to those already present. The patient develops a hectic temperature, amyloid degeneration of the viscera may supervene, the limb becomes more and more deformed, abnormal movements from relaxation of ligaments may exist, but these can usually be demonstrated only under an anæsthetic, and finally the patient, exhausted partly by the discharge, partly by the pain, and partly by the want of sleep, becomes emaciated, and may even die, unless prompt measures are taken for his relief.

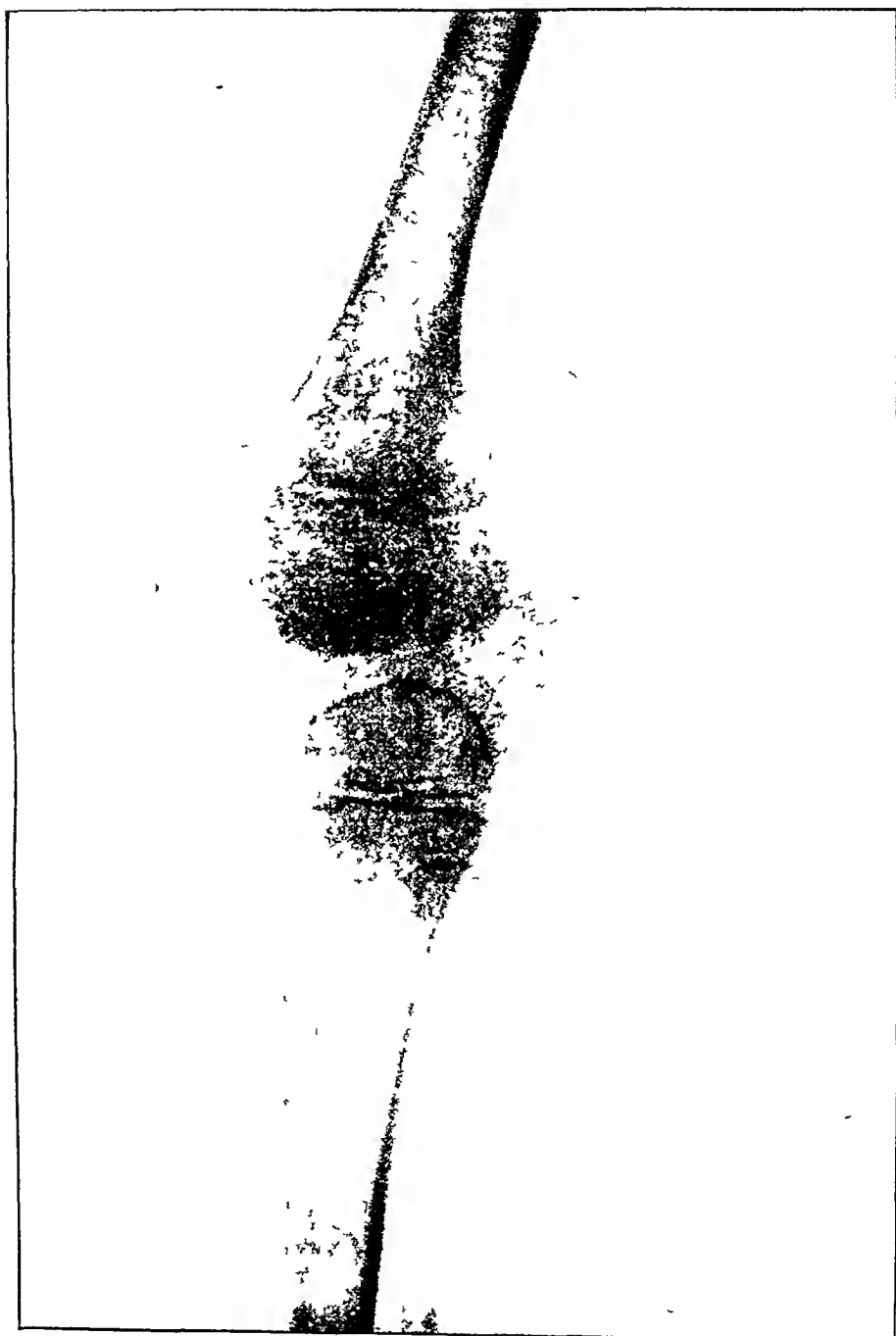
**Results** —(a) If seen in the early stages, and suitably treated, the disease may be entirely cured, and a moveable joint result. (b) More frequently the articular structures are so severely damaged, that a cure can only be established by means of ankylosis. Unless measures have been adopted to maintain the limb in a satisfactory position, permanent deformity may ensue. (c) If sepsis has been admitted, the patient will probably develop hectic or amyloid disease from chronic toxæmia, and from this he may succumb. On the other hand, in a few instances he may survive such dangers, the sinuses alternately drying up and discharging, although he remains a permanent invalid, and the joint is crippled. (d) Acute miliary tuberculosis is occasionally met with as a complication of this affection, whilst similar associated disease of the lungs, brain, kidneys, or other viscera, may be lighted up.

The **Prognosis** is mainly influenced by the condition of the individual and his surroundings. In children of the better classes, where every hygienic and medical assistance can be given, recovery generally follows, unless there is a strong counterbalancing hereditary tendency. Amongst the poorer classes, and especially in 'slum children,' the outlook is correspondingly serious. Moreover, the extremes of life are unfavourable. Babies resist tuberculous invasion badly, and patients over fifty have comparatively little recuperative power, hence radical rather than conservative measures have often to be resorted to in these two classes.

The **Treatment** of tuberculous joints varies not only with the articulation affected, but also with the type of patient, and the extent to which the disease has advanced.

1. *Hygienic Treatment* —Localized tuberculosis can often be cured in the early stages by suitable local and constitutional treatment.

PLATE XXIX



TUBERCULOUS DISEASE OF KNEE-JOINT, SHOWING INVASION OF PATELLA



The limb should be kept absolutely at rest by means of splints, plaster of Paris, etc., and elevated if there is much pain. Rest must include freedom not only from mobility, but also from pressure, and therefore in the lower extremity, if the patient is allowed to walk, the limb must be kept from the ground by putting a patten on the other boot. An endeavour must be made at the same time to correct any faulty position of the limb by a process of gradual extension, made at first in the direction of the displacement, and with only just sufficient energy to keep the joint surfaces at rest and counteract the tonic muscular contraction which is tending to produce a fixed deformity, it may be necessary to employ tenotomy for this purpose. Any form of apparatus which depends upon a screw mechanism to straighten out a limb is certain to increase intra-articular tension, and therefore is not to be used. The sudden application of force under an anæsthetic is usually unadvisable, since tuberculous material may thereby be disseminated through the system. Counter-irritation by blistering or iodine paint, or combined with pressure in the form of Scott's dressing, is often useful in promoting repair. The general health should be improved by sending the child to a suitable sanatorium or the seaside, giving it plenty of good food, and administering cod-liver-oil and syrup of the iodide of iron. The process of cure is slow, and the patient and his friends must be warned as to the necessary length of the treatment.

2 As accessories to this hygienic treatment the following plans may be adopted

(a) *Parenchymatous injections* of iodoform suspended in glycerine into the articular cavity, or into the substance of the synovial membrane, have been much recommended of late, and have apparently done good, 10 parts of iodoform are mixed with 20 of sterilized water, and made up to 100 with sterilized glycerine. About an ounce of this fluid is injected into the joint cavity, or smaller quantities are scattered through the surrounding tissues. An inflammatory reaction follows, but when this has subsided—after perhaps a fortnight—the injection may be repeated. It is perhaps of most value when there is a definite effusion into the joint.

(b) A new plan of local treatment was suggested by Bier, of Kiel a few years back, it consists in inducing *venous engorgement* of the diseased tissues by applying an elastic bandage above and below the joint, but only loosely over it, the pressure is kept on for two or three hours daily, if the patient can bear it, and during the intervals a splint is applied. The process is based on the observation that phthisis rarely develops in association with mitral regurgitation, whereby pulmonary engorgement is induced, whilst if the cardiac lesion supervenes in a phthisical subject, the lung symptoms improve. It is too early yet to say what the final verdict as to this method will be, but the results hitherto gained are encouraging\*. It must never be employed when septic sinuses are present, as it considerably

\* *Archiv für klin Chirurgie*, vol. XLVI, bd II, p 306

aggravates the trouble by providing increased pabulum for the micro organisms

3 *Abscesses* are, if possible, dealt with sufficiently early and in such a manner as to obviate the need for prolonged drainage. To this end they ought never to be left long enough to allow the skin and subcutaneous tissues to become involved, but as soon as a collection can be detected it should be tapped by a large trocar and cannula, the cavity well irrigated, and injected with iodoform emulsion. It is wise to incise the skin with a knife, and not to puncture it with the trocar, the irregular wound made by the latter does not heal quickly, a stitch closes the incision and assists satisfactory healing.

Of course, when the skin is reddened, and the pus subcutaneous, the abscess must be incised and drained in the usual manner, any thin and undermined skin being snipped away.

4 If hygienic treatment cannot be carried out satisfactorily, or if the disease progresses in spite of such measures, *operation* may be necessary. Two chief plans need consideration, viz, arthrectomy and excision, but it must be remembered that each joint presents peculiar features, and that considerations referable to one do not necessarily hold good for another.

*Arthrectomy* or erosion of the joint consists in laying open the cavity and removing all the diseased tissues that can be reached. The synovial membrane is scraped or cut away, diseased foci of bone are gouged out, and the resulting cavities disinfected by carbolic acid and packed with sterilized iodoform. Ankylosis is the usual, though not invariable, result. It is obvious that this proceeding is not equally applicable to all joints. Thus in the hip the opening is usually made from the front, and unless there is great laxity of the capsule and some increase in size of the acetabulum, the back and upper part of the joint cannot be reached. The knee, ankle, and elbow are perhaps the most favourable situations for this operation. The chief advantages over excision are that it interferes neither with the immediate length nor with the subsequent growth, whilst there are no extensive sections of bone which may become subsequently infected.

*Excision* of a joint is a more radical measure, but has the disadvantage of removing healthy as well as diseased tissues, whilst the fact that it may encroach in children on the epiphyseal structures renders it undesirable as a routine procedure. Increased confidence in conservative measures has rendered this operation much less common than formerly. The chief conditions for which it is now employed in tuberculous disease are as follows: (a) For complete disorganization of the joint, or when extensive bone mischief is present, (b) to prevent ankylosis in certain joints, such as the elbow and temporo-maxillary, (c) to determine a rapid and radical cure with synostosis in such a joint as the knee, as soon as it is evident that the natural result of the disease must be an ankylosed limb. Surgical art often produces a more efficient cure than Nature under these circumstances, since all foci can be removed. A natural cure often

leaves many tuberculous foci encapsuled, and these may subsequently cause pain and lead to recurrent attacks of inflammation (d) Deformity with or without ankylosis may also need excision

The choice of operation in any particular case is not always an easy matter, and before reaching a decision several factors must be taken into consideration (i) The *age* of the patient As already mentioned, the fact that typical excisions encroach on the growing ends of bones renders them undesirable in children Even if growth is not stopped thereby, it may be rendered irregular, and subsequent deformity may ensue In the knee, however, it is possible to remove a thin slice of articular cartilage, so as to gain synostosis of the two epiphyses without interfering with the growth As regards advanced age, opinions differ somewhat, but the shoulder and knee may be excised satisfactorily at a much greater age than the elbow, wrist, and ankle Probably forty to forty-five years would be looked on as the age limit for the latter, but we have had excellent results from excising the knee and shoulder at a much later period of life (ii) The *general health and vitality* of the individual must be fairly good if either erosion or excision is to be undertaken In weakly individuals amputation is often the better practice, as also when hectic fever is pronounced and amyloid disease of the viscera advanced (iii) The *extent* of the bone mischief If this is slight, erosion may be undertaken, if more extensive, excision But if the bone trouble is so exaggerated that the removal of the diseased tissue would leave a flail-like, useless limb, then amputation is required (iv) It is useless to attempt erosion where there is much invasion of the soft tissues, excision may even be impracticable under these circumstances, and amputation may be the only hope (v) Where septic sinuses are present, and especially if any subacute or acute sepsis exists, free incisions should be made to give relief to tension and allow the inflammatory disturbance to quiet down before any serious operative measures are considered

5 *Amputation* is required in cases which, in spite of every care, are steadily going from bad to worse, and where the patient's health and strength are being sapped by the disease It is also required not unfrequently in old people, and where the mischief in the bones and soft parts is very extensive In addition, it is indicated in patients where excision has been undertaken and failed, either from the limb becoming subsequently flail-like or useless, or from recurrence owing to incomplete eradication, or from the advent of sepsis Lastly, if the disease is present in two joints at one time, or in a joint and some other organ, neither of which is improving, total removal of one focus of mischief will often induce a rapidly favourable change in the other

### *Tuberculous Disease of Special Joints*

The **Shoulder-joint** is but rarely affected in children, and not very commonly in adults The disease usually starts in the head of the humerus, affecting subsequently the synovial membrane, and perhaps also the glenoid cavity If abscesses form, they are likely to point



either in front of or behind the deltoid, in the former case extending along the synovial membrane lining the bicipital groove. Pathological dislocation of the head of the bone forwards and upwards may occur at a late stage, somewhat resembling an unreduced subcoracoid dislocation. In the traumatic variety, however, the fixity is greatest at first, and the movements subsequently improve, in the tuberculous form, the limitation of movement gradually increases until complete ankylosis supervenes. Excision of the head of the bone is almost always required in order to effect a cure.

In the **Elbow** the disease is most common in young adults, and is often primarily osseous, commencing in the olecranon or outer condyle of the humerus. In children the synovial membrane is first affected, frequently starting in the superior radio-ulnar articulation. The swollen synovial membrane bulges on either side of the olecranon and tendon of the biceps, and can often be felt over the head of the radius. Sinuses form by the side of the olecranon, or an abscess may burrow upwards along the ulnar nerve and open on the inner aspect of the arm. Prolonged immobilization, followed, if need be, by incision and partial removal of the synovial membrane, often suffices in children, leaving, however, a stiff elbow, which must be left alone until growth is completed. In adults excision is the correct practice, and the results are very satisfactory, provided that a sufficient amount of bone is removed, and the muscular attachments are interfered with as little as possible. If expectant treatment is adopted, the arm should be flexed to a right angle, and with the hand midway between pronation and supination, so that, if ankylosis follows, the limb may be in the most useful position. Arthrectomy is occasionally adopted, and is best accomplished by means of an H-shaped incision over the olecranon, which process of bone is divided at its base and turned upwards, so as to expose thoroughly the interior of the articulation. After removing all diseased tissue, the olecranon is replaced and wired to the shaft of the ulna.

In the **Wrist** diffuse disease of the synovial membrane and bones is met with, starting most frequently from the former structure, if primarily osseous, it usually commences in the lower end of the radius. It may also extend from a tuberculous affection of the adjacent tendon sheaths. A characteristic doughy swelling forms over the dorsum, displacing the extensor tendons, whilst the palmar aspect of the wrist is also puffy. Sinuses develop most frequently on the dorsal aspect or by the side of the flexor carpi radialis tendon. Conservative measures may bring about a cure, and every effort should be made to avoid excision, since the result of this proceeding is almost always the production of a weak and flail-like hand, so that the constant use of a leather support is essential after healing has occurred. In elderly people amputation is often the only resource.

Diseases of the **Hip-joint** and of the **Sacro-iliac Articulation** are separately considered (pp. 685 and 694).

The **Knee-joint** is, perhaps, more often affected with tuberculous disease than any other articulation. It appears to start in the synovial

membrane or bone with almost equal frequency, if the bones are first affected, the primary focus is usually situated on the inner aspect of either the femur or tibia. Sequestra are found in nearly one-half of the cases in which the bone is affected, becoming more frequent as the age advances. The disease runs a typical course, and needs no special comment. When the joint has become disorganized, the tibia is liable to be displaced horizontally backwards, flexed and externally rotated, and ankylosis in this position is difficult to remedy, even by operation.

Prolonged immobilization on a back-splint, or preferably the application of a Thomas's knee-splint (Fig 238), so that the patient can walk about in the fresh air, together with iodoform injections and constitutional treatment, will be effectual in many cases. Failing this, a modified arthrectomy may be undertaken in children where growth is still progressing, and to carry it out an incision should be made across the front of the joint from condyle to condyle, as for an excision, dividing either the ligamentum patellæ, or perhaps the patella, which is subsequently wired together. The whole of the synovial membrane is then dissected away, special attention being directed to the subcrural pouch and the back of the joint. A thin slice should be removed from the surfaces of both tibia and femur, and if the epiphyseal cartilages are not encroached upon, the growth of the limb is not impaired to any great extent, although it may become irregular and lead to some deformity, *e.g.*, well marked flexion, or genu-recurvatum (p 440). In adults, where the bones are not too extensively involved, so that on section broad healthy surfaces can be apposed, excision is a most satisfactory operation, provided, of course, that the synovial disease is also removed. As soon as it becomes evident that the only possible natural cure is by ankylosis, and this evidence would be given by fixation of the patella to the femur, or by severe starting pains at night, excision is justifiable and advisable. It cuts short the disease, and provides a quicker and more radical cure than Nature can possibly effect. Incomplete removal of the disease, either in the synovial membrane or bone, may determine recurrence, if this cannot be dealt with effectively, amputation may be required, and then a long posterior flap is the only healthy tissue available for covering the bone. Under other circumstances the supracondyloid amputation can be adopted.

**The Ankle-joint**—Tuberculous disease of this joint usually commences in the synovial membrane rather than in the bone. If primarily osseous, the astragalus is more frequently affected than the lower end of the tibia. The whole region becomes occupied by a

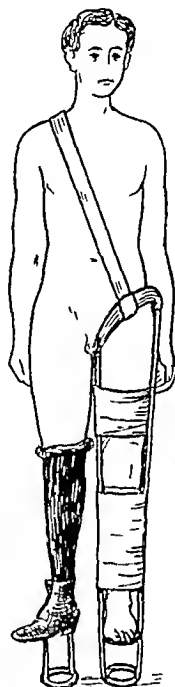


FIG 238 —THOMAS'S KNEE-SPLINT APPLIED

pulpy swelling, which first pushes forwards the extensor tendons and bulges in front of the malleoli, and subsequently appears on either side of the tendo Achillis. The foot is maintained in a position of slight plantar-flexion so as to bring the narrower portion of the upper surface of the astragalus into the tibio-fibular mortice. Flexion and extension of the foot are usually limited or lost, but with care the lateral movements (inversion and eversion) which occur at the mid-tarsal and sub-astragaloid joints can be undertaken without pain. In the early stages prolonged rest and immobilization in plaster of Paris are required. Excision of the joint gives fairly satisfactory results in adults, but not unfrequently fails to eradicate the disease, owing to the fact that, when once the astragalus is involved, the tuberculous process is likely to spread to the articulations placed beneath it, and so to the other bones of the foot. When there is any doubt as to the condition of the astragalus, that bone should be removed at the same time as the lower ends of the tibia and fibula. Where the disease is more extensive, a supramalleolar amputation of the foot will be necessary.

For diseases of the **Bones and Joints of the Foot**, see p. 589

### Syphilitic Diseases of Joints

Although syphilitic disease of joints is rare in proportion to the prevalence of syphilis, yet several varieties have been differentiated and recognised. (1) In the later stage of the secondary period a *chronic* form of *synovitis* occurs, evidenced by passive effusion into the joint, with or without pain, and usually persisting for some time. Any joint may be attacked in this way, perhaps the knee most commonly, and the affection is often symmetrical in its distribution. The effusion may be only slight, but is frequently very considerable (hydrarthrosis), and a marked feature in the condition consists in the rapid variations in the amount of swelling, even from day to day. In some few cases this affection resists all treatment, and leads to ultimate disorganization. (2) Gummatous inflammation of the perisynovial fibrous tissue, which may or may not extend to the adjacent bone, is met with in the tertiary period. It either appears as a localized hard nodule, resembling in measure a fibrous tumour, and then causing but little trouble beyond a sense of painful weakness in the articulation, or it is more diffuse in its distribution, leading to a moderate effusion, and later on to much thickening and infiltration of the capsular and other ligaments, and resulting in considerable impairment of its movements from cicatricial contraction. Some of these gummatous nodules may break down and ulcerate. (3) A diffuse *gummatous infiltration of the synovial membrane* itself is also seen. It closely simulates a tuberculous synovitis, from which it is often impossible to distinguish it, except by the rapid onset and the presence of other syphilitic phenomena. (4) A *chondro arthritis*, described originally by Virchow, is the syphilitic analogue of osteoarthritis. It commences by fibrillation of the matrix of the cartilage,

and proliferation of the cells. The cartilage softens, and becomes eroded by friction of the articular surfaces. The bone thus exposed is worn away, and curiously 'pitted' and excavated. It is recognised from osteo-arthritis by the facts that there is usually but little or no pain, that the eburnation of the exposed bone is less extensive, and therefore crepitus is but little marked, whilst the typical osteophytic growths, causing 'lipping' of the joint margins, are absent. The eroded areas, moreover, do not correspond with the sites of intra-articular pressure, and are more rounded and punched out, and not arranged in linear grooves, as in the latter disease. It is not uncommonly associated with a gummatous thickening of the synovial membrane, and, indeed, the hollows or pits above mentioned may be filled with caseous material, derived from degeneration of this tissue.

The Treatment in the early manifestation consists in the administration of mercury, and the judicious application of pressure with or without immobilization, according to the requirements of the case and the joint affected. In the tertiary forms iodide of potassium in gradually increasing doses has a rapidly beneficial action, which confirms the diagnosis, it may be occasionally combined with a small amount of mercury, either given internally, or applied locally if any ulcerative lesion exists. In the most pronounced cases, where the pain is severe and disorganization of the joint has occurred, excision may be necessary, and the results are often very satisfactory.

### Osteo-arthritis

1896. J.

Although this disease is extremely common in this country and has well-marked characteristics, its nature is still obscure, as is evident from the number of names applied to it, such as *chronic rheumatoid arthritis*, *rheumatic gout*, *arthritis deformans*, *arthritis semilis*, *arthritis sicca*, etc. There is not the slightest doubt that several types of disease have been confounded together under this title, and although at the present time it is admitted that rheumatic and gouty conditions are to be excluded, yet it is probable that we are still including more than one type of chronic articular trouble.

**Ætiology** — Exposure to damp and cold is doubtless an important factor in the production of osteo-arthritis, especially in elderly people, or when some depressed condition of the nervous system is superadded, whether such be due to worry, anxiety, or to defective nutrition. In other cases where there is no question of exposure, the affection is by some attributed to nervous influences (Senator, Ord), and particularly to affections of the uterus and ovaries, which it is supposed are capable of inducing reflex changes in the joints. Others, again, attribute it to auto-intoxication due to indigestion of duodenal origin. Recently a theory of bacterial causation has been propounded, and although it cannot be considered as proven, yet evidence in favour of its probability is steadily accumulating. It is supposed that the organisms find their way into the joints from some other focus of infection, and in this connection it is interesting to note the statement

that in a large series of cases 55 per cent were preceded by some other infective fever or disease (Bannatyne). They develop in the joints, and produce toxic bodies which act locally by inducing destructive phenomena of a special type, whilst by their general absorption various trophic and nervous symptoms are caused, whose existence has been constantly noted, but for which hitherto there had been no adequate explanation. Such an origin will also explain the presence of enlarged glands in the neighbourhood of some of the affected joints (Still). Several observers have found bacteria within the joints, and Bannatyne and others have described a short bacillus,

the ends of which stain deeply, whilst the intervening portion remains unstained, causing it to look like a diplococcus.

Traumatism plays an important part in the production of certain types of osteo-arthritis, and Lane is emphatic in maintaining that these cases should be relegated to a different category, and be known as *chronic traumatic arthritis*, the changes, however, are so similar to those of osteo-arthritis that we prefer to consider it a subdivision or variety. The injury may be slight in nature, such as a sprain or strain, or more severe, such as a fracture or dislocation involving the articular surface, thus, it is not uncommon to see it following Colles's fracture or one of the

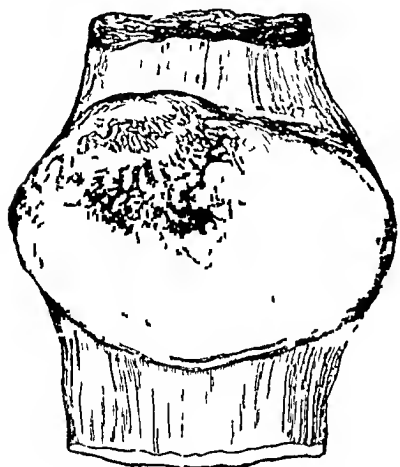


FIG. 239.—PATELLA FROM EARLY CASE OF OSTEO ARTHRITIS SHOWING FIBRILLATION OF CARTILAGE (HOWARD MARSH)

cervix femoris. Abnormal pressure maintained for a long time also causes changes of a similar type, and thus many of the joints of labouring men are deformed in a peculiar fashion, according to the special type of work and the particular joints that are exposed to strain. Senile degeneration also seems to produce articular lesions of a very similar character.

**Pathological Anatomy**—The disease commences in the articular cartilage, the matrix of which cracks and undergoes fibrillar changes, and presents a villous appearance, resembling the pile of velvet (Fig. 239). The cartilage cells proliferate, so that the capsules contain many instead of one, and these, giving way, discharge their contents into the joint. The cartilage thus softened is readily worn away by the movements of the articulation, and the exposed surface of bone becomes hard, sclerosed, and polished like ivory (eburnated). This usually occurs in certain definite directions. In hinge joints the surfaces become grooved longitudinally, whereas in ball-and-socket joints, like the hip, the head is eroded in a circular manner. This condensed tissue does not extend very deeply, and immediately beneath it the cancellous bone is of a more open texture than usual,

and filled with fatty medulla. In spite of the sclerosis, the articular end of the bone is continually being worn away, and this may go on to such an extent as to lead to actual shortening of the limb. Concurrently with this destruction, new bone formation is taking place at the margins of the articular cartilage, producing irregular osteophytes, which have been likened to the gutterings of a candle. They are preceded by an overgrowth of cartilage, in which ossification takes place secondarily.

When such outgrowths have been produced more or less evenly around the joint margin, a characteristic 'lipping' of the edge of the cartilage results (Fig 240). Sometimes these osteophytes attain to a large size, and by interlocking may lead to ankylosis of the joint. The synovial membrane is usually thickened, and the villi occasionally proliferate, and may reach such dimensions as to be felt through the skin, rolling under the finger. They are red, vascular, and succulent during life, but after removal and preservation in spirit, they look shrunken and insignificant. This overgrowth is often associated with excessive effusion, though usually the affection is of a dry type. Occasionally cartilaginous nodules develop in the villi of the synovial fringes, later on becoming ossified, and if detached constitute one form of loose cartilage.



FIG 240 —LATE STAGE OF OSTEO-ARTHRITIS OF KNEE, SHOWING DESTRUCTION OF THE ARTICULAR CARTILAGE AND EBURNATION OF THE EXPOSED BONE IN LONGITUDINAL GROOVES (FROM COLLEGE OF SURGEONS' MUSEUM)

The margins of the surfaces are distinctly lipped

**Clinical History** —Three chief types of this disease may be described

1. The *chronic monoarticular variety* is that most frequently seen by surgeons, and is constantly brought about by injury. Pain and creaking of the joint on movement are the early symptoms of this affection. There may be very little swelling, unless effusion is present, but pain, especially at night, is most troublesome, being usually increased on changes of weather, particularly if rain is threatening. The pain and stiffness are most marked after keeping the parts at rest, and diminish when the limb is used. As the disease progresses, the movements become more and more impaired, and the crepitus

more of an osseous type, the ends of the bones are felt enlarged and lipped, and deformity soon becomes obvious. Exacerbations in the symptoms occur from time to time, resulting in increased crippling of the articulation. Finally, the limb may become absolutely useless, partly from the pain and partly from the limitation of movement produced by the osteophytes. Wasting of the adjacent muscles is also a marked feature.

It is usually seen in elderly people, and may supervene very quickly after an accident, such as fracture or bruising of the cervix femoris, and then the destructive phenomena may progress at a rapid rate. When it appears in younger people, the osseous lesions are much less evident.

2 The *chronic polyarticular variety* arises independently of traumatism, and is most commonly seen in females of middle life. It may commence in one joint and spread to others, or it may appear in many joints simultaneously. Most frequently one or more of the phalangeal articulations is the starting-point, particularly the terminal ones. The joints become stiff and swollen, are tender, and small nodular bony outgrowths develop at the bases of the phalanges, which are known as Heberden's nodosities. The trouble gradually spreads to other joints, and although there are often remissions, yet the condition progresses steadily until the patient may be entirely crippled thereby. Well-marked overgrowth of bone and eburnation of the articular ends are characteristic features of this type. Sometimes there is considerable effusion, accompanied by overgrowth of the synovial villi, but this is unusual.

3 The *acute polyarticular variety* does not often come to the surgeon for treatment, at any rate in the early stages. It usually attacks young or comparatively young people, and females rather than males, frequently following some infective trouble, such as influenza, scarlatina, tonsillitis, etc. It is often ushered in by a distinct febrile attack with persistent increase in the rate of the heart-beat, trophic and vasomotor phenomena are often co-existent, such as patches of pigmentation, clammy cold hands, and rapid muscular atrophy. The smaller joints of the hands and feet are mainly affected, and that more or less symmetrically, although the terminal inter-phalangeal articulations often escape. The capsules are distended with a certain amount of effusion, causing the joints to look spindle-shaped, and at first there is but little osseous mischief. In not a few cases a very characteristic deformity in the shape of ulnar adduction of all the fingers occurs. Gradually the trouble spreads to other and larger-joints, and osseous manifestations appear, but the progress is slow, and may be to a large extent arrested by treatment. Neighbouring lymphatic glands may be enlarged in the early stages.

It is important to note that gouty and rheumatic troubles may be associated with osteo-arthritis: the rheumatic affections may precede, the gouty usually follow.

The **Diagnosis** of osteo-arthritis *per se* is not often difficult in a well-marked case, the crepitus, pain, and enlargement of the ends of the

bones, together with the slight amount of effusion, constituting a tolerably characteristic picture. From simple *chronic synovitis* it may be known by the history and smaller amount of effusion, and by the pain and rigidity being frequently more marked after rest, and diminishing after the joint has been actively used. There is more difficulty in distinguishing the form associated with increased effusion and enlargement of the synovial villi, careful examination may, however, enable the surgeon to make out these villi moving to and fro in the joint under his hand, whilst possibly the ends of the bone may be lipped. For diagnosis from *chronic rheumatism* and *Charcot's disease*, see pp 657 and 678.

The diagnostic points between polyarticular osteo-arthritis and *gout* are suggested in the following table

	Osteo arthritis	Gout
Sex	Females	Males
Type of patient	Poor, ill-nourished, depressed, anxious, often exposed to damp and cold	Well to-do and well-nourished people
Onset	Insidious	Sudden and obvious
Locality of onset	Usually in hands, especially in the thumb	Feet, especially metatarsophalangeal joint of great toe
Type of attack	No obvious swelling or redness	Red and painful at first, with skin shiny over the joint
Pain	Slight andaching	Severe and acute
Symmetry	Well marked	Not usually present
Deposit of urate of soda	Absent	Present

The **Prognosis** is usually unfavourable. The fact that many joints are affected is an indication that there is a considerable constitutional tendency to the development of the disease, and although it may be temporarily combated with success, still, sooner or later, the patient is almost certain to be crippled by it. The affection of only one joint often points to a traumatic origin, and the outlook is correspondingly brighter, but where the disease attacks several parts of the body, there is but little hope of checking it, and indeed cases are known in which every joint has successively become implicated, the patient dragging on a weary existence, never free from pain, and usually in a cramped or sitting posture, until death from exhaustion supervenes.

**Treatment**—For this troublesome complaint there is, unfortunately, little that can be effected in the way of cure, although much can be done to alleviate. Locally, the articulations should be protected from cold and injury by being swathed in flannel, whilst stimulating embrocations and sedative applications may be beneficially employed. It is not advisable to maintain the joints absolutely and always at rest, otherwise they tend to become fixed, and their mobility is seriously limited at an unnecessarily early date. Moreover, it is often found that the more a joint is moved, the easier and less painful do those movements become, and hence regular massage



is desirable. As to general treatment, the individual is warned against exposing himself to cold and damp, and, since the disease is often considered to be due to perverted or diminished nervous activity, all possible sources of irritation and worry should be removed. At the same time the nutrition must be improved, and plenty of good food, cod-liver oil, etc., administered. A large number of different drugs have been tried for this complaint, but none of them are very satisfactory. Perhaps the best is iodide of sodium combined with some alkaline purgative and hepatic stimulant, such as sulphate of soda. Natural mineral waters and baths are often beneficial, those of Bath and Buxton in this country being most frequently recommended. Arsenic is sometimes useful in cases where the disease is probably of nervous origin.

Occasionally operative treatment in the shape of *excision* may be useful in this complaint, but only when the disease is limited to one joint, and when it has progressed to such a stage as seriously to cripple the patient's usefulness, as in the knee-joint, elbow, or the shoulder, or when the act of mastication is impaired, owing to an affection of the temporo-maxillary articulation. In suitable cases excellent results are obtained.

The *hip joint* is not uncommonly the seat of osteo arthritis in old people, and it always causes a considerable amount of pain, especially on flexion of the limb, rendering sitting difficult and walking uncomfortable, whilst the movements are steadily more and more curtailed. The limb appears at first to be slightly increased in length, but later on becomes shortened from erosion of the head and atrophy of the neck of the bone, the trochanter is also much thickened and more prominent than usual, on account of the associated atrophy of neighbouring muscles. Well marked crepitus is obtained on moving the thigh. The acetabular cavity is increased in size owing to the formation of a projecting rim or lip. If a patient falls on the affected hip, some difficulty may be experienced in making a diagnosis from fracture of the neck of the thigh-bone. The previous history and the facts that the trochanter rotates around its normal centre, and is unduly prominent rather than approximated to the median line, and that the ilio-tibial band is not relaxed, as in fractures, should suffice to prevent mistakes.

When the *temporo-maxillary joint* is affected, the condyle of the jaw becomes larger than usual and somewhat flattened, whilst the eminentia articularis is partially absorbed and the glenoid cavity increased in size, so that there is a tendency for the condyle to slip forwards owing to the action of the external pterygoid muscles. If only one joint is affected, the bone is carried towards the sound side, but when both are involved the chin becomes prominent owing to a forward displacement of the whole bone. Pain and crepitus are experienced on opening the mouth, rendering mastication difficult, and even impracticable. If ordinary treatment fails to give relief, the affected condyle of the jaw should be excised.

For osteo-arthritis of the *Spine*, see Chapter XXIV.

## Neuropathic Arthritis (Syn Charcot's Disease)

This disease, bearing the name of the late Professor Charcot, is a peculiar affection of joints met with in the course of locomotor ataxia. It is slightly more common in women than men, and is almost always an early manifestation, occurring usually between the lightning-like pains and the onset of the ataxic symptoms. The most typical form is lighted up by some slight injury—*e g*, a strain or sprain—and is



FIG 241—HYPERTROPHIC VARIETY OF CHARCOT'S DISEASE OF KNEE JOINT (FROM COLLEGE OF SURGEONS MUSEUM)

The patella (PAT) can be seen poised on the top of a mass of new bone formed by the welding together of a number of smaller portions formed in the peri-synovial tissues



FIG 242—ATROPHIC VARIETY OF CHARCOT'S DISEASE OF KNEE JOINT (FROM COLLEGE OF SURGEONS MUSEUM)

The bones are cleanly eroded, and no new formation is present. The patella is reduced to a mere shell, one-eighth of an inch thick.

characterized by a rapid painless distension of the joint with a light coloured serum, which may also extend into the communicating bursæ, there is some amount of effusion into the surrounding cellular tissue, although without œdema. This distension may be so rapid that abnormal mobility or even dislocation may occur at the end of a few hours. The joints most frequently affected are the knee, hip, and shoulder, occasionally more than one articulation is involved. The course of the case varies, in some few instances the fluid is gradually absorbed and the joint returns to its normal size and shape,

although somewhat weakened. Sometimes the attacks of distension recur, and after each the joint becomes more and more crippled. In others, however, and perhaps most frequently, the bones become eroded to a considerable extent, the ligaments stretched, and a weak, flail-like articulation remains, in which the ends of the bones are atrophied and displaced (Figs 242 and 243). In other instances new osseous formations occur here and there under the synovial membrane, especially in cases where there is much distension, so that on compressing the swelling between the hands a sensation is produced similar to that imparted by grasping a bag of bones. Occasionally, under these circumstances, the osseous masses become welded together, giving rise to large overgrowths, which lead subsequently to fixation of the joint (Fig 241). The disease sometimes runs a more chronic course, and then closely resembles osteo-arthritis, since there is but little effusion, whilst the ends of the bones become



FIG 243 —CHARCOT'S DISEASE OF LEFT KNEE AND SHOULDER

The great atrophy of the ends of the bones, and the resulting dislocations, are clearly evident

eroded, and osteophytes, perhaps of great size, form around the edges of the cartilages, leading to defective mobility and crepitus.

The **Diagnosis** of Charcot's disease from *osteo-arthritis* is, as a rule, readily made if one remembers the following points. Charcot's disease is usually characterized by a rapid onset, limitation to one joint, considerable effusion, absence of pain, atrophy of the ends of the bones, and a tendency to the production of a weak, flail-like joint, whilst the general signs of tabes are also observed. Osteo-arthritis, on the other hand, comes on slowly, often affects many joints, has but little effusion, is very painful, and is attended with overgrowth tending to produce ankylosis. In the more chronic cases the distinguishing features are much less evident.

As to pathological anatomy, the changes observed are practically identical with those seen in osteo-arthritis, except that the erosion is more rapid, the effusion greater, and the formation of osteophytes less constant.

The **Treatment** of Charcot's disease consists in keeping the limb at

rest on a splint and applying elastic pressure. The effusion, when considerable, may be removed by an aspirator, but is very likely to re-collect. In the later stages, where the joint is entirely disorganized, some form of fixed apparatus may be applied to render the limb more useful, or, failing that, amputation may be required.

The same type of articular lesion occurs in *Syringomyelia*, a disease which consists in a gliomatous development in the spinal cord, and usually in the cervico dorsal region. It is characterized by loss of the senses of pain, and of heat or cold, but tactile and muscular sensibility persists. Atrophy of various muscles of the hand or fore-arm also occurs, whilst trophic lesions, e.g., whitlow, perforating ulcer, etc., are common. Joint troubles are observed in at least one-third of the cases, mainly in the upper extremity, tabes generally affecting the lower. Either atrophic or hypertrophic phenomena are developed, and the course is identical with that of Charcot's disease, except that suppuration is a little more likely to follow, owing to the frequent presence of septic sores.

Somewhat similar in nature to Charcot's disease is the chronic arthritis met with in many conditions where the nervous supply to a limb is impaired as a result of central or peripheral disease of the nervous system. Thus, it may follow spinal bifida, hemi- or para-plegia of cerebral or spinal origin or may be secondary to a peripheral neuritis, due to either injury, syphilis, gout, diabetes, leprosy, etc. The terminal articulations of fingers or toes are those most often affected (acro arthritis), although larger joints may be involved. They become swollen and painful, and after a time ankylosis ensues.

### Hæmophilic Diseases of Joints

In hæmophilia (p. 292) any injury to a joint, such as a sprain or wrench, may lead to a copious effusion of blood into the articular cavity, which becomes suddenly swollen, distended, and evidently full of fluid. There is some pain on movement, the part becoming hot and tender, whilst when coagulation has taken place it is hard and firm. Total recovery may ensue, or the joint be left weak and liable to recurrence of hæmorrhage and inflammation. The effects on the articular surfaces are curious: the cartilages usually retain their normal colour, but become thin, worn, and rough, especially at the points of greatest pressure, fibrillar degeneration of the matrix may occur, and in some cases the cartilage has been found totally absent, being replaced by fibrous tissue. Ecchondroses subsequently developing into bone are formed at the margins of the joint surfaces, the changes thus produced being somewhat akin to those of osteo-arthritis. The ligaments and synovial membranes may remain of a normal texture, or are slightly thickened, and usually of a russet-brown colour. Adhesions are often present, causing considerable impairment of mobility. The *Treatment* consists in keeping the part at rest, and applying ice in the early stages, whilst, later on, friction, massage, and pressure may be employed. The surgeon must never attempt to aspirate the joint, even with a fine needle.

### Loose Bodies in Joints

Several varieties of loose bodies are met with in joints, which may be described as follows. (1) The so-called 'melon-seed bodies' consist of fibrin derived from altered blood-clot, or more frequently from a

fibrinous exudation in cases of very chronic tuberculous disease. At first irregular in shape and laminated in texture, they are generally transformed into round or flattened pellets or elongated masses by the movements of the articulation. Bursæ and tendon sheaths are much more frequently affected than joints. The number present is usually considerable, whilst there is also some glairy effusion, causing distension and a certain amount of creaking. A few years ago we operated on a case in which the knee-joint was occupied by a number of rounded yellowish-white foreign bodies, several of which were nearly as large as walnuts, they were probably of hæmorrhagic origin.

2) Portions of articular or inter-articular cartilage may be broken off



FIG 244—FOREIGN BODY IN JOINT, PROBABLY DERIVED FROM A PORTION OF ARTICULAR CARTILAGE (FROM COLLEGE OF SURGEONS' MUSEUM)

A, cartilage, B, bone

as a result of mechanical violence. They usually consist of a smooth rounded mass of articular cartilage enclosing a central bony nucleus (Fig 244). (3) They are sometimes derived from the development of cartilaginous nodules in the synovial fringes or villi, which may either remain adherent and become pedunculated, then occasionally wearing a bed for themselves in the articular surface, or may be totally detached. Such structures are

usually lobulated and irregular in shape, and consist of calcified cartilage or bone, whilst a certain amount of normal cartilage is also present (Fig 245). This condition may result from osteo-arthritis, but sometimes the cartilaginous cells from which they are derived have persisted as a 'foetal residue'. (4) Finally, portions of bone may become separated from their surroundings, and remain loose in the cavity. Thus, ecchondroses may be broken off in cases of osteo-arthritis, or portions of the articular surface detached by mechanical means, or even sclerosed areas isolated by a process of rarefying osteitis without suppuration, constituting what Paget originally described as 'quiet necrosis'.

Although cut off from all vascular supply, the growth of some of these loose bodies is said to continue, owing to the highly nutritious fluid which bathes their surfaces.

The **Symptoms** caused by this condition are produced by the loose body being occasionally caught between the articular surfaces, leading to a temporary locking of the joint and severe pain, owing to the stretching of the ligaments. The fixation is but momentary, since the foreign body is readily displaced, but an attack of subacute synovitis follows. When this has happened several times, the ligaments are likely to become relaxed, and the joint somewhat loose and distended. Under such circumstances it may be possible to feel the foreign body and to shift its position, but frequently the surgeon, owing to its ready mobility, is unable to detect the intruder as it slips

away into the interior of the joint. From this point of view, the German term 'Gelenkmaus' (joint mouse), as applied to this affection, is most happy. The knee-joint is that most frequently affected, but the same condition occurs in the elbow and temporo-maxillary articulation.

The Diagnosis between a loose body and a *displaced semilunar cartilage* in the knee joint is not always easy, since in both conditions painful locking of the joint occurs. The fixation, however, is but momentary in the case of a loose body, but may persist until reduced in the latter, whilst a localized spot of tenderness may be detected corresponding to the site of the injury to the inter articular cartilage. Moreover, the history of the case is very different, since the dislocation of a semilunar cartilage is always primarily referred to some twist or sprain of the joint, whereas with a loose body no such traumatic influence need be present.



FIG 245 —LOOSE CARTILAGE IN JOINT, PROBABLY DEVELOPED IN A FRINGE OF SYNOVIAL MEMBRANE (FROM COLLEGE OF SURGEONS' MUSEUM)

A, cartilage, B, bone

The Treatment consists in the removal of the foreign body by an open operation. In the knee-joint a vertical incision should be made, about 2 inches in length, extending a little above and below the line of the articulation. It should be placed about 1 inch from the patella, on whichever side the loose cartilage presents most frequently, but preferably on the outer. If possible, the foreign body should be fixed by the finger in one of the lateral pouches of the joint before making the incision. The capsule and synovial membrane are opened, the loose body removed, and the cavity washed out, if thought desirable, with sterilized saline solution. The wounds in the synovial membrane, capsule, and skin are then carefully sutured. The joint should be kept at rest subsequently for two or three weeks, and an elastic knee-cap worn for some time.

### Neuralgic Joints

In neurotic individuals, especially young women, a neuralgic condition of the joints is commonly met with, simulating disease of the articulation. On careful examination the pain is found to be super-

ficial, not increased by jarring the articular surfaces together, and often not strictly confined to the joint. The movements are apparently limited, but if the attention of the individual is diverted, or anæsthesia induced, they are found to be perfectly free. There are no signs of effusion into the cavity, and no starting pains at night. Occasionally a similar condition is met with in men, where there is no suspicion of hysteria.

The *treatment* is constitutional and local. The former is directed towards improving the general health, and correcting any error in the uterine functions. The latter is best accomplished by the use of cold douches and electricity, although counter-irritation in the shape of blisters, or even the actual cautery, has an excellent moral effect.

### Ankylosis

By ankylosis is meant a condition of immobility, partial or complete, of a joint, resulting from some preceding inflammation of the articular structures.

The term *false* ankylosis is sometimes applied to a condition resulting from extra-articular lesions. Such may be either fibrous or osseous, and is due to cicatricial contraction of the skin, shortening of muscles, or even to the development of bony tissue within them (*myositis ossificans*). *True* ankylosis always involves the articular structures, and is either fibrous or bony.

*Fibrous or incomplete* ankylosis results (a) from thickening and contraction of the ligaments, such as often occurs after gonorrhœal or rheumatic affections, (b) from the formation of cord- or band-like adhesions within the joint, after acute synovitis, (c) from erosion of the cartilage and exposure of the bone, granulations sprout up on each side, and by their union lead to dense fibroid adhesions between the articular surfaces. Some amount of movement is possible in most of these cases.

*Complete or osseous* ankylosis (synostosis) arises from the union of either the whole or part of the opposing surfaces left by the destruction of the cartilage, the bond of union, at first fibro-cicatricial, being subsequently ossified (Fig 246), it may also be due to the interlocking and fusion of osteophytes, formed at the margin of the bone in osteo-arthritis or Charcot's disease.

The **Causes** of ankylosis are very variable, but may be arranged as follows

- 1 Injury to the articular surfaces, as from fractures which run into a joint

- 2 Non-suppurative inflammations of joints, involving the formation of fibrous adhesions or the contraction of ligaments, as in synovitis, whether traumatic, rheumatic, gouty, gonorrhœal, etc., and the early stages of acute or tuberculous arthritis

- 3 Destruction of bones, associated or not with articular diseases, as in Pott's disease of the spine, and the later suppurating stages of acute or tuberculous arthritis

4 Nervous affections are occasionally the cause of ankylosis, by leading to a chronic form of arthritis. The lesions may be central, as in spina bifida, tabes, and syringomyelia, or peripheral, as in neuritis, Raynaud's disease, diabetes, leprosy, or division of nerves.

5 Long-continued abnormal pressure of contiguous bones may result in ankylosis, as in scoliosis or osteo-arthritis of the spine. In the latter affection the immobility may be due either to ossification of ligaments or to the interlocking of osteophytes.

The position in which ankylosis occurs and the effects thus produced differ according to the joint affected.

In the *shoulder* there is but little displacement, and the existence of immobility is of comparatively little importance, owing to the free movements of the scapula and clavicle. The deltoid muscle is usually much atrophied. The *elbow-joint* is very commonly ankylosed on account of its exposed position, and the frequency of fracture-dislocations in its neighbourhood. The formation of callus filling up the olecranon and coronoid fossæ, and the adhesions likely to form within the joint in these cases, readily explain its frequency. The most favourable position for ankylosis is when the arm is flexed to a little more than a right angle, with the hand midway between pronation and supination. By this means access to the mouth is possible, and the patient can use his hand for feeding purposes. The *wrist* is

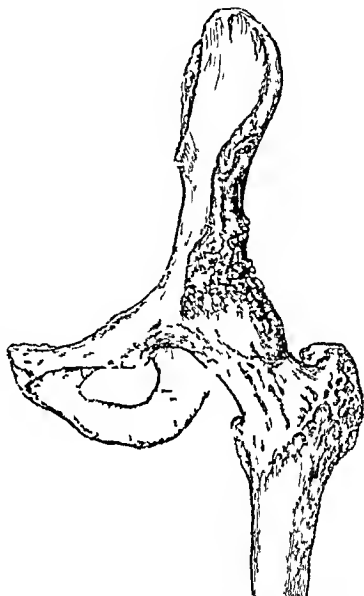


FIG 246 —ANKYLOSIS OF HIP-JOINT IN GOOD POSITION AFTER EARLY HIP DISEASE (HOWARD MARSH)

most commonly fixed as a result of gonorrhœal or rheumatic synovitis. In the *hip-joint* (Fig 246) much depends upon the treatment as to whether the ankylosis takes place in a good or bad position. In neglected cases the thigh may be in a position of adduction and internal rotation, crossing in front of the other leg. Occasionally a *scissor-like deformity* has resulted from inflammation of both hip-joints, one leg lying in front of the other, progression is accomplished with difficulty, the body twisting at each step, and crutches are often needed. In the *knee-joint* ankylosis in an absolutely straight position of the limb should be aimed at, unless complete synostosis is likely to occur, when a slight degree of flexion may render the leg more serviceable. In the *ankle-joint* considerable trouble may arise from immobility, unless the foot is at right angles to the leg.

**Treatment**—*Fibrous* ankylosis, due to massive adhesions, is often best left alone, since even if the adhesions are ruptured by manipulation, they are almost certain to re-form. Moreover, in an old-standing



case marked atrophy of bone is often present, and a fracture can easily be produced. The existence of deformity, however, justifies the employment of a certain amount of force in order to straighten the limb. If due to tuberculous disease, the possibility of lighting up the old mischief or disseminating the virus must be kept in mind, and the haphazard methods of unscientific bone-setters in such cases have often been followed by disastrous results.

For *osseous* ankylosis various operative measures may be employed, with a view either to correct the deformity, or in other cases to restore movement to the part. At the *shoulder, wrist, and ankle* nothing need be undertaken unless obvious and troublesome deformity is present. At the *elbow* excision may be beneficially employed, and with every prospect of gaining a moveable joint. If, however, ankylosis is present in a child, the operation should be deferred until growth has come to an end. Ankylosis of the *knee* in a false position needs cuneiform osteotomy, or the resection of a wedge-shaped portion of bone, in order to secure a straight, rigid and useful limb.

Ankylosis of the *hip-joint* in a bad position is best treated by dividing the neck or the upper part of the shaft of the femur. Several operations have been devised for this purpose. 1. Adams' subcutaneous osteotomy of the neck of the bone consists in passing a sharp-pointed bistoury down to the anterior surface of the cervix femoris, from a point midway between the trochanter and the anterior superior spine of the ilium. A track is thus made, allowing the introduction of an Adams' osteotomy saw, by means of which the neck of the femur is divided subcutaneously. The limb is put up in a straight position, and the bone allowed to re-unite. 2. The same result may be obtained by an open method, making the same incision as in the anterior operation for excising the joint (p. 699). 3. Gant suggested division below the lesser trochanter. This may be accomplished by cutting down on the bone from the outer side and chiselling it across.

As to the operation to select in any particular case, the surgeon's choice must be guided by the condition of affairs present. A skiagram of the neck of the femur should always be taken, so as to ascertain its condition. Sometimes it is stunted, and has practically disappeared, in other cases it is much thickened, and forms a large bony mass passing from the trochanter to the ilium, and probably containing encapsuled foci of tuberculous material. In both these conditions subtrochanteric osteotomy must be employed, but preferably in an oblique and not a transverse axis, it is not unusual to find that the adductor muscles are so contracted that their attachments to the pubes require section before the limb can be satisfactorily straightened. Division of the cervix can only be recommended when that structure is of normal length and size.

### Hip-joint Disease

Although the term 'hip-joint disease' is usually applied to a tuberculous arthritis, it is not the only affection involving this articulation. Simple synovitis occurs in the course of rheumatic, gonorrhœal, or pyæmic affections. Acute arthritis is also met with secondary to an acute infective osteo-myelitis of the upper end of the femur, and is evidenced by all the ordinary signs of that affection, separation and necrosis of the upper epiphysis being a frequent result. Osteo arthritis is not uncommon (p 676), whilst Charcot's disease may also occur, but none of these call for special mention here.

#### Tuberculous Disease of the Hip (*Syn* *Morbūs Coxæ*, *Tuberculous Coxitis*, *Coxalgia*)

differs in no respect from the same disease as it affects other joints, and hence no detailed notice of the pathological anatomy is required. Suffice it to say that it may originate in the synovial membrane or bone, more frequently in the latter, and then commencing either beneath the articular cartilage or in connection with the epiphyseal cartilage of the caput femoris (Fig 247). Very rarely the disease becomes circumscribed in the neck of the

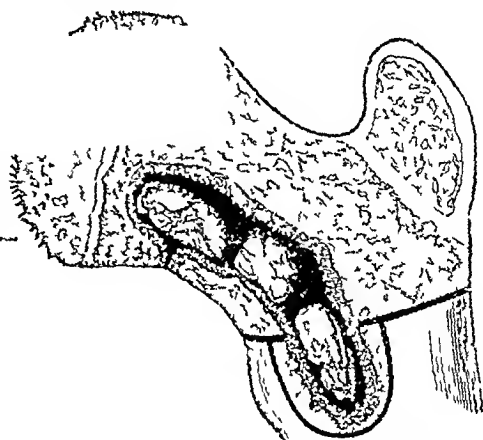


FIG 247 —TUBERCULOUS DISEASE OF THE HEAD AND NECK OF THE FEMUR, SHOWING SEQUESTRA IN AN ABSCESS CAVITY AND COMMUNICATION ON THE UNDER SIDE OF THE NECK WITH THE JOINT (TILLMANN'S)

The epiphysis of the head has been invaded, and the articular cartilage entirely stripped off by the disease, the continuous black line indicates the amount of bone which it would be necessary to remove.

bone, forming a chronic abscess, the diagnosis of which is exceedingly difficult. More usually the disease spreads to the under side of the neck, and thus involves the synovial membrane, which passes into a state of pulpy degeneration. The substance of the epiphysis is invaded, and caries of the head is thereby produced, together with necrosis or ulceration of the cartilage. The acetabulum undergoes similar changes, from the contact and backward pressure of the diseased head the posterior acetabular margin is absorbed and the cavity extended, whilst at the same time a new rim of bone forms beneath the adjacent periosteum at a slightly higher level, thus giving rise to what is known as a 'travelling acetabulum' (Fig 248).

In this way the socket is increased both in size and depth, travelling backwards and upwards with the head of the bone towards the dorsum illi. Other factors assisting in the displacement of the head of the bone are the tonic action of the muscles, keeping the limb

in a position of flexion, adduction, and inversion, thereby causing a considerable portion of the head to project out of the acetabulum, and the early softening and destruction of the posterior ligaments, which are much thinner than those in front of the joint. Occasionally a mass of protuberant granulations sprouts up from the centre of the cavity, and may also assist in this process. Should the acetabulum be perforated, a tuberculous abscess is likely to form within the pelvis. The adjacent pelvic bones may either become thickened by



FIG 248 — FEMUR AND ACETABULUM IN HIP DISEASE (KING'S COLLEGE HOSPITAL MUSEUM)

The epiphysis of the caput femoris has been practically destroyed, and the acetabulum is enlarged by absorption of its posterior margin and displaced upwards (*travelling acetabulum*). The ramus of the ischium and pubes have been removed.



FIG 249 — EARLY STAGE OF HIP DISEASE (RIGHT SIDE) IN A CHILD (FROM A PHOTOGRAPH)

The black line is drawn from one anterior superior spine to the other, and shows not only the amount of abduction present, but also the tilting down of the pelvis on the affected side.

the deposit of osteophytes, or carious, if sepsis is present, necrosis may also supervene.

**Clinical History** — The patient, usually a child, is observed to limp, and may complain of pain either in the hip or inner side of the knee, the latter being due to the fact that both joints are supplied by the same nerves, viz, the anterior crural, sciatic, and obturator trunks. There may be some history of injury, but not necessarily. On examining the limb in the *early stage*, it is usually found to be

*apparently lengthened* (Fig 249), whilst the thigh is slightly wasted. The nates are flattened, and the gluteal fold lost, conditions partly due to atrophy of the muscles, partly to the flexion of the limb. The joint is more or less rigid, and pain is produced on attempting to move it, or on jarring the leg, as by striking the heel or trochanter. The position assumed in this early stage is one of slight and increasing flexion, abduction, and eversion (Fig 250, A), the reason for this being that thereby the ligaments, and especially the ilio-femoral, are most relaxed, and the capacity of the joint is at its greatest. The latter fact has been demonstrated in the healthy cadaver by inserting the nozzle of a syringe into the joint through the acetabulum, and forcibly injecting fluid, when this position is at once assumed. The flexion and abduction, however, are not always evident, since the flexion is masked by lordosis of the spine (Figs 251 and 252), and the abduction

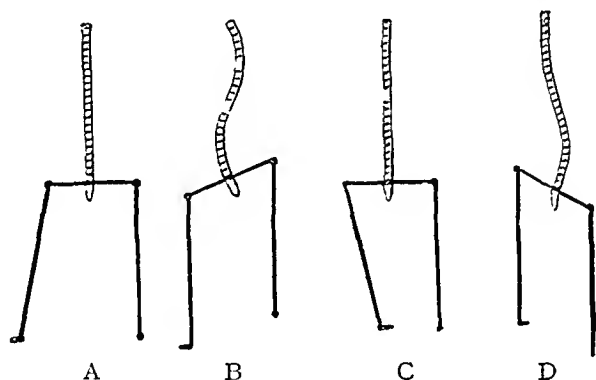


FIG 250—DIAGRAM TO ILLUSTRATE THE POSITIONS ASSUMED BY THE LIMB IN THE EARLY AND LATE STAGES OF HIP DISEASE

A represents the position of abduction taken by the right limb in the early stage of hip disease, and B, Nature's method of masking this by tilting the pelvis down on the affected side, whilst the other leg is adducted, the effect of this on the spine, in causing a lateral deflection, is also indicated. C shows the same thing in the later stage, when adduction is present, and the pelvis is tilted upwards on the affected side, thus producing apparent shortening (D).

by the pelvis being tilted down on the affected side, producing thereby apparent lengthening of the diseased limb and lateral curvature of the spine, with its lumbar convexity towards the affected side (Fig 250, A and B). The sound leg being brought into a position of adduction, the parallelism of the limbs is maintained. The flexion can be demonstrated by any method which obliterates the lumbar curve of the spine, as by fully bending up the sound limb on the abdomen, the affected thigh rising at once from the bed and forming an angle which indicates the amount of flexion (Fig 252). The abduction is demonstrated by laying a rod across the two anterior superior spines, and placing another at right angles to its centre. This will not correspond with the line of the body or of the limb, but makes an angle with it. The eversion cannot be masked. The rigidity is easily demonstrable

in that all movements of the hip-joint are greatly limited, thus if an attempt is made to bend the affected thigh on the abdomen, the corresponding side of the pelvis is raised with it from the bed

As the disease progresses, and the bones become more extensively affected, the pain increases, with nocturnal startings, whilst abscesses form, and a certain amount of fever and constitutional disturbance is caused thereby. The position of the limb also changes, for although the flexion is maintained and even increased, adduction and inversion are now associated with it. The pelvis is tilted up on the affected side (Fig 250, C and D), causing *apparent shortening*, lateral curvature with a lumbar convexity to the sound side, and abduction of the

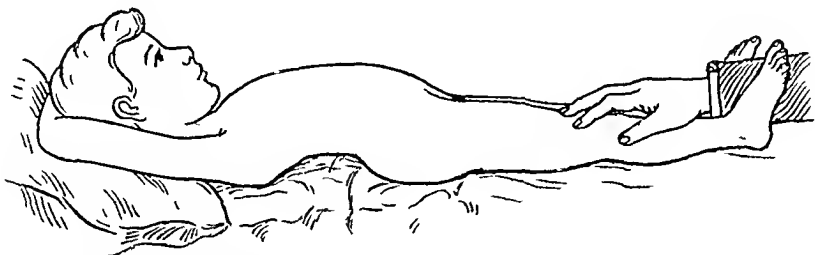


FIG 251—HIP DISEASE, WITH WELL MARKED COMPENSATORY LORDOSIS CAUSED BY EXTENDING THE LEGS FLAT ON THE TABLE

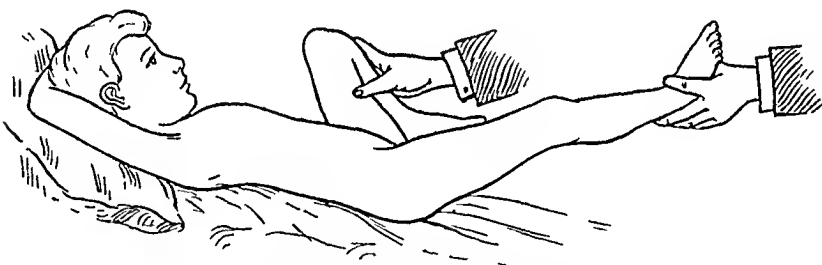


FIG 252—ON FLATTENING THE SPINE AGAINST THE COUCH BY RAISING THE UNAFFECTED LEFT LEG AND PRESSING IT UP AGAINST THE ABDOMEN, THE DEGREE OF FLEXION OF THE RIGHT THIGH AT ONCE BECOMES OBVIOUS

healthy limb. No satisfactory cause for this position can be given, but it is usually attributed to the yielding of the posterior and outer part of the capsule, together with infiltration and weakening of the small external rotator muscles, allowing the adductors and internal rotators unopposed play.

When an abscess has formed, the most usual situation for it to point is a little in front of and internal to the great trochanter, close to the insertion of the tensor fasciæ femoris. It may reach that spot either from an opening in the anterior part of the capsule, coming thus to the surface along the line of least resistance, or it may burrow from the posterior portion of the capsule along the rotator muscles and superior gluteal nerve. Less frequently abscesses pass directly backwards to open in the gluteal region, or forwards along the pubo-

femoral ligament, pointing on the inner side of the femoral vessels below Poupart's ligament. As a rare complication, the tuberculous process may extend to the bursa under the psoas tendon, which usually communicates with the joint, leading to the formation of an abscess in the lower part of Scarpa's triangle, and occasionally a typical psoas abscess results from an extension upwards within the sheath of the muscle of a tuberculous infection from this bursa. An intra-pelvic abscess following perforation or disease of the acetabulum may either burrow upwards, and come to the surface on the inner side of

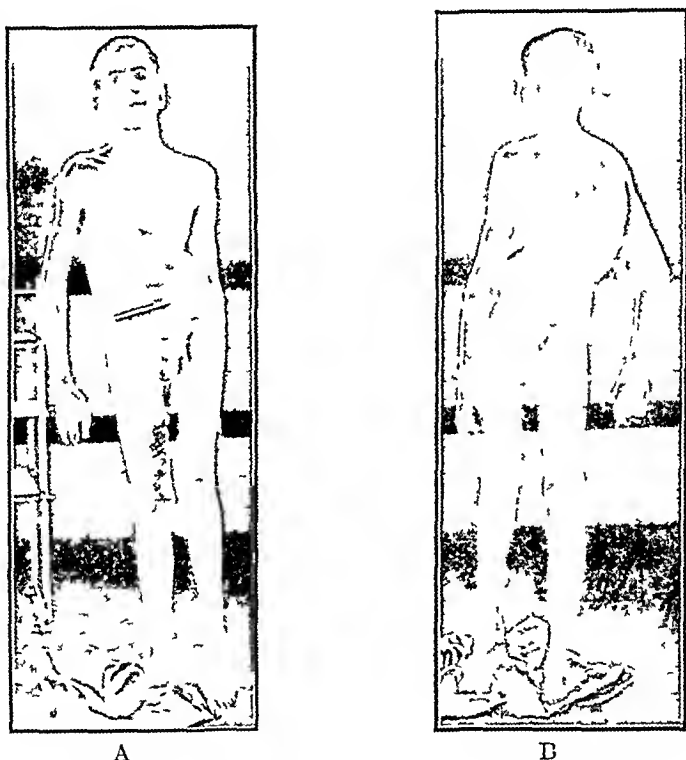


FIG. 253.—POSITION OF THE LIMB IN THE LATER STAGES OF HIP DISEASE

In A a white line has been drawn between the two anterior superior spines to indicate the tilting of the pelvis upwards on the affected side necessitated by the adduction of the limb. Some amount of flexion was present, but this was not marked. In B the secondary curves of the spine are well seen.

the vessels above Poupart's ligament, or it may gravitate downwards, and burst in the ischio rectal fossa, close to the tuber ischi.

The final stage of the disease is one of *real shortening* (Fig 253), due to erosion of the head of the bone and its displacement backwards upon the dorsum ili. The position assumed is one of increased flexion, adduction, and inversion, whilst if septic sinuses persist, hectic fever and amyloid changes in the viscera are likely to follow.

At any stage cure by ankylosis may be obtained, but unless the

abnormal position has been corrected by extension, deformity is almost certain to be present

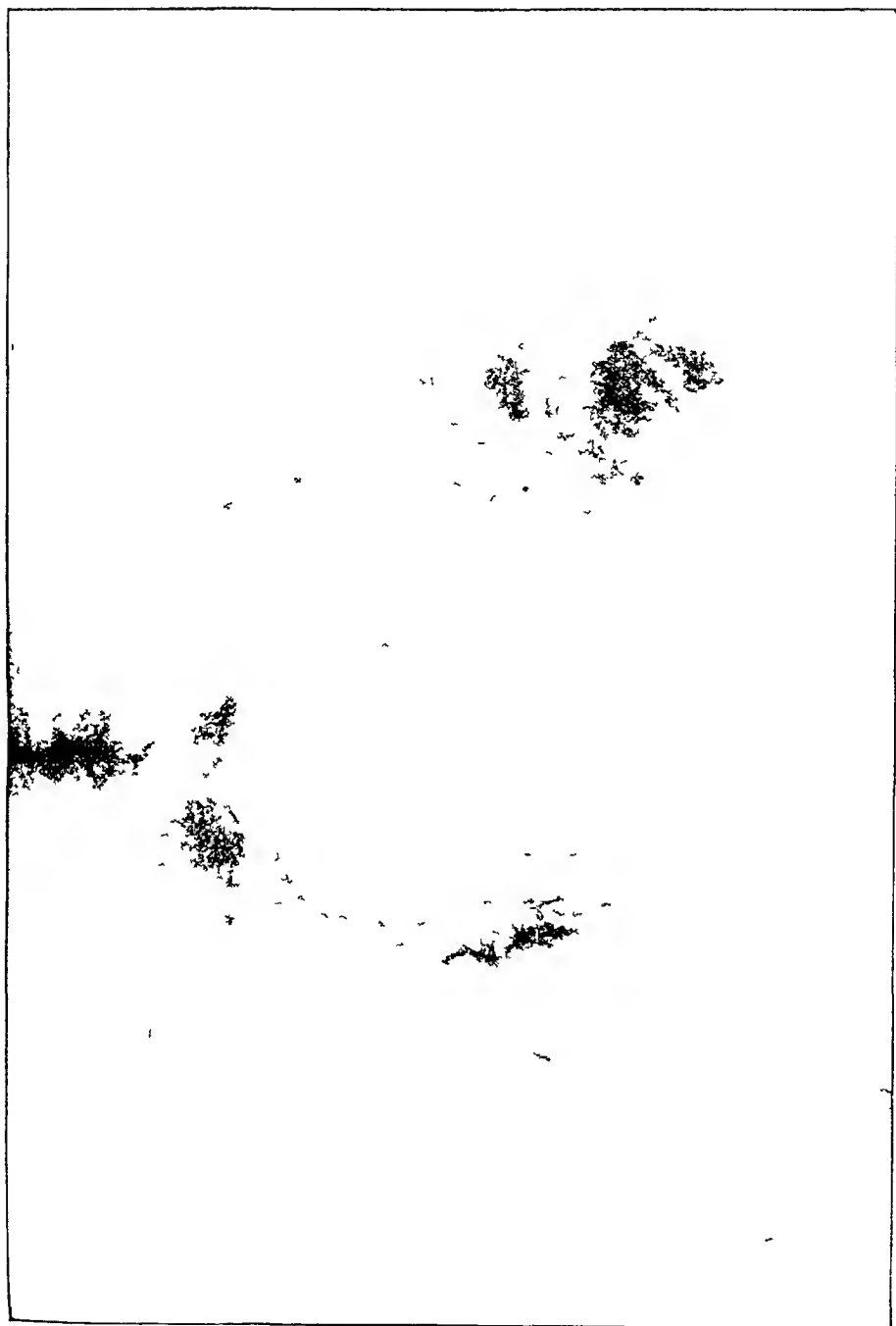
The **Diagnosis** of hip disease appears to be a matter of considerable difficulty to some, if we may argue from the mistakes which commonly occur. The pain in the knee present in the early stages leads to its frequently being mistaken for disease of that articulation, a very slight amount of care in the examination should prevent such an error. From disease of the *opposite hip*, it is recognised by the relative mobility of the thigh on the two sides. The diagnosis from *sacro iliac* disease is given at p 695. *Spinal mischief* may also be confounded with it, if a psoas abscess points at any of the ordinary situations in which sinuses form in connection with the hip-joint. The presence of spinal deformity and the ability to perform the test movement for hip disease should readily enable the surgeon to make a correct diagnosis, but it must not be forgotten that the two conditions may co-exist. If the limb can be put into what is known as the tailor's position—that is, flexion to a right angle with marked abduction and eversion—one may be practically certain that hip disease is not present.

An *encapsuled abscess in the neck of the femur* is a condition which it is very difficult to distinguish from true hip disease. A constant deep boring pain is complained of, which is increased by pressure over the neck, or by jarring the trochanter, but if the limb is manipulated gently, it can be proved that the movements of the joint are not really impaired. Radiography is a useful aid in making a diagnosis of this condition.

The **Prognosis** of hip disease is by no means unfavourable if the condition is properly treated. Of course, the patient is liable to develop acute tuberculosis or tuberculous disease elsewhere, or, if abscesses are allowed to become septic, serious complications—such as pyæmia, sapræmia, hectic and amyloid disease—may ensue. Apart from these, however, no serious consequences affecting life need be feared, although the usefulness of the limb may be seriously crippled from shortening or ankylosis, especially if the latter occurs in a faulty position.

The **Treatment** of hip disease must be conducted along the same lines as for tuberculous lesions generally. In the *early stages* the limb is kept at rest by the application of a Liston's splint, or it may be placed between sandbags, and a weight and pulley attached. By this means not only is rest assured, but deformity is prevented. If the amount of flexion is slight, the limb may be allowed to lie on the bed in the horizontal posture, this will possibly induce some compensatory *lordosis*, but as the muscular spasm relaxes, the curvature of the spine disappears. When, however, a considerable degree of flexion is present, extension must be made along the axis of the flexed limb, which is supported on pillows. It will be found that after a few days the flexion diminishes, and the limb will then gradually assume the horizontal position. Should this precaution not be adopted, the extension merely produces *lordosis*, and the pain from intra-articular tension is increased thereby. The general health of the patient must

PLATE XXX



SKIAGRAM OF PELVIS SHOWING TUBERCULOUS DISEASE OF RIGHT HIP-JOINT  
The head of the bone is displaced upwards, irregular in shape, and evidently invaded with granulation tissue. The acetabulum is similarly affected.





at the same time be attended to, and cod-liver oil and syrup of the iodide of iron may be administered with benefit. When the more urgent symptoms have disappeared, a Thomas's hip-splint is applied, so as to enable the patient to get about (Fig 254). This consists of a flat bar of malleable iron, about an inch and a half wide, extending from the axilla to below the knee, it is shaped so as to fit the varying curves of the body, and cross-pieces embrace the trunk at the level of the nipples, as also the thigh and the calf, it is firmly bandaged to the body and limb. A patten is placed under the boot of the sound leg, and the patient allowed to get about on crutches. This apparatus should be worn for at least six months after all signs of active disease have disappeared. It may also be employed in the earlier and more painful stages if it is at first bent so as to accommodate itself to the flexed position of the limb, as the effect of the rest becomes evident in a diminution of muscular spasm, the splint can gradually be straightened out, so that at length the limb is fully extended.

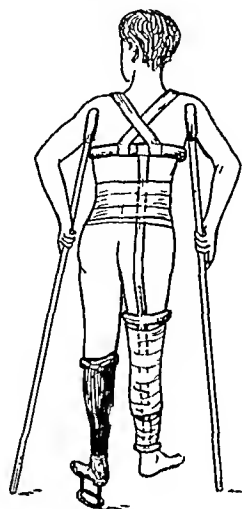


FIG 254 — THOMAS'S  
HIP SPLINT APPLIED

When abscesses form, they may be opened antiseptically and drained, or preferably tapped and injected with iodoform, the former precautions as to rest and constitutional treatment being still maintained. More extensive operative measures—such as *excision* of the head by the *anterior* method (p 699)—are sometimes undertaken in the early stages to cut short the disease, especially when prolonged treatment is impracticable, as amongst the poor, or when the general health and constitutional powers are defective. The removal of the whole head necessarily involves the upper epiphysis, and hence defective growth of the femur results, as well as immediate shortening. For these reasons, as also because repair is possible in most cases without operation (when there is a certain amount of recuperative power and prolonged treatment is feasible), this proceeding, at one time so common, is being discarded more and more in favour of conservative measures.

It is sometimes possible, however, to save some portion of the head, and if so, this should always be attempted. A very successful series of cases has recently been published, in which the joint was opened from the front, the interior freely curetted (in one case after a temporary dislocation of the head), the bone scraped, and in more than one case a channel gouged along its anterior wall to expose and remove a deep focus. Indeed, when one attempts to save the head of the femur in this way, it is always well to remove the compact tissue from the front of the neck so as to expose and explore the epiphyseal line. By this plan, shortening and defective growth can to a large extent be avoided.

In the *later stages*, and especially when sinuses have formed in the gluteal region or behind the trochanter, *excision* by the *posterior* method (p 699) is preferable, this is usually an easy matter, since the head is probably eroded and displaced. The sinuses should, if possible, be included in the incision, but under any circumstances must be opened up and scraped. When the acetabulum is extensively implicated, the disease can only be satisfactorily dealt with by removing the head of the bone, and the posterior method affords the best means of subsequent drainage, of course, this presumes that the general condition of the patient has not been seriously undermined, and that there is a good prospect of gaining a useful limb. Otherwise *amputation* through the hip-joint is required, especially when the mischief has extended into the pelvis, or when, after excision, a weak, flail-like limb results or osteo-myelitis supervenes. It is also needed when after excision sinuses persist and lead down into the acetabular cavity, from which there is a plentiful secretion of pus, and over the entrance to which the upper end of the femur is drawn, thereby obstructing the escape of the discharge, and rendering dressing both difficult and painful. The operation often gives most excellent results, the patient's condition rapidly improving. Removal by the anterior racquet method is perhaps the most convenient.

### Disease of the Sacro-iliac Joint

Tuberculous disease of this joint is most commonly met with in adults, but rarely in children. It may commence in the synovial membrane, but is frequently the result of mischief starting in the pelvic bones, especially the ilium. The **Pathological Anatomy** calls for no description, inasmuch as it follows the ordinary course of tuberculous disease.

The **Clinical Signs** consist of pain and a sense of weakness in the lower part of the back, increased by standing, walking, or any movement—such as coughing, sneezing, and the like—which calls the flat abdominal muscles into sudden action and drags on the ilium. It is of a very unpleasant character, a sensation as if the pelvis were coming to pieces being experienced by the unfortunate individual. Owing to the fact that the lumbo-sacral cord passes in front of the articulation, pain is often referred to the gluteal region or down the leg. Movements of the limb cause pain if the pelvis is not supported, but can be freely performed if the pelvis is steadied. Compression together of the innominate bones, or their forcible separation, is the means of most effectually demonstrating the existence and situation of the pain. The patient is unable to stand or to put any weight on the affected limb, and hence limps during walking, allowing his body to lean forwards, and making use of a stick. There is apparent lengthening on the affected side, but on measurement from the anterior superior spine to the internal malleolus the leg is found to be of the same length as its fellow. This appearance is due to the fact that the whole innominate bone is tilted downwards and forwards, so that the anterior superior spine is at a lower level and more prominent than that on the opposite side. The region of the synchondrosis is often swollen, puffy, and tender, whilst

after a time abscesses form, which may either point immediately over the articulation, or burrow upwards into the lumbar region, or forwards into the groin, or downwards into the pelvis, opening in the ischio-rectal fossa. The last is a most serious complication, since it necessarily introduces the septic element.

The **Diagnosis** needs to be made from sciatica, hip disease, and spinal disease. *Sciatica* is known by the character of the pain, which shoots down the back of the thigh in the course of the great sciatic nerve, which may be distinctly tender on pressure. There is no apparent elongation of the limb, and compression together of the pelvic crests is painless. From affections of the *hip-joint*, sacro-iliac disease is recognised by the fact that, if the pelvis is supported, the thigh may be moved in all directions without great discomfort, whilst compression of the pelvis in hip disease causes no pain. Moreover, in the advanced stages of hip disease, there is apparent or real shortening, a condition never noticed in the sacro-iliac affection. From *spinal disease*, the diagnosis should not be difficult if a careful examination of the spine and pelvis is made.

The **Prognosis** of sacro-iliac disease, though usually stated to be unfavourable, is not necessarily so if asepsis is maintained, it is the admission of the septic element that constitutes the main danger. When affecting girls, it may lead to subsequent deformity of the pelvis and trouble in parturition.

**Treatment** in the early stages consists in absolute rest, with the application of a pelvic support, and attention to the general health, combined possibly with local counter-irritation. When abscesses form, they should be freely opened, and if diseased bone can be felt with a probe, it should be scraped or cut away, and the parts swabbed over with pure carbolic acid. Occasionally it is necessary to remove the posterior part of the iliac crest in the neighbourhood of the posterior superior spine in order to gain access to the diseased area, this may be accomplished by the chisel or trephine through a vertical incision, and we have had a number of excellent results from this proceeding.

### Excision of Joints

Excision of joints is an operation which, though formerly undertaken in a few isolated instances for compound fractures and dislocations, has only during the past fifty years been established on a scientific basis, or utilized to any great extent. The late Sir William Fergusson was one of the chief pioneers in this branch of operative surgery, and to his skill and insight we owe much of what has thus been gained. Since the introduction of antiseptics, however, the operations have been still further elaborated, and excision is now undertaken for many conditions that formerly would not have been so treated. The chief articular lesions for which excision, partial or complete, is now recommended are as follows: (1) For compound dislocations or fracture-dislocations, (2) for various forms of simple or comminuted fracture in the neighbourhood of joints where ankylosis is likely to follow, and either interfere seriously with the utility of the joint or fix it in a bad position.

the shoulder and elbow are the joints most frequently dealt with in this way, (3) for some forms of congenital or old-standing dislocation which cannot be otherwise remedied, (4) in the later stages of acute arthritis, where the ends of the bones are carious, the joint disorganized, and chronic suppuration is present, (5) in tuberculous arthritis, where palliative treatment has failed to cut short the disease, or where disorganization of the joint has occurred with erosion of the ends of the bones, (6) for ankylosis of certain joints, consecutive to arthritis, either acute, tuberculous, or syphilitic, especially if in a bad position, (7) for osteo-arthritis in special regions

The results to be attained necessarily vary in the different joints, and according to the particular causes. Sometimes ankylosis in a good position is all that can be expected, in others a freely moveable pseudarthrosis, in some cases the removal of certain diseased tissues is the primary object of the operation, whilst in others no disease is present. All these varying conditions must be taken into consideration in determining the nature and extent of any excision.

The late Professor Ollier of Lyons emphasized and established the benefits to be derived from subperiosteal resections in certain cases. Necessarily, every excision must lead to considerable interference with the peri-articular structures, muscles and tendons have to be detached from their insertions, and portions of the bones removed. If, however, the periosteum is raised, together with the attached muscles and tendons, prior to sawing or cutting the bones away, a more satisfactory reproduction of the articular structures follows, and the movements of the joint suffer less interference than if one cuts away the periosteal envelope with the bone. Of course, where the periosteum is invaded with tubercle, this should not be attempted, whilst in some joints—such as the elbow—there is no advantage to be derived from it, since there is always a tendency to too great a formation of bone, and this would possibly be exaggerated by a subperiosteal resection. It is rather in the operations undertaken for traumatic lesions that this plan is to be recommended.

In a small text-book like this we must perforce limit ourselves to a description of the methods most commonly adopted, and refer students to special works on Operative Surgery for further details.

**Shoulder-joint**—Excision of the shoulder-joint may be needed for tuberculous disease, for the later stages of acute arthritis, occasionally for osteo-arthritis if the disease is limited to this articulation, for compound or comminuted fractures, and possibly for simple fractures of the anatomical neck when associated with dislocation of the small detached head of the bone. In old unreduced dislocations where passive movement is impracticable, and there is little hope of improvement, excision may give excellent results.

**Operation**—The patient lies on the back, the shoulder projecting somewhat over the edge of the table, and with a sandbag beneath the scapula to steady it. The arm being slightly rotated inwards, an incision is made from a point midway between the coracoid process and the acromion, extending downwards and outwards for 3 or 4 inches through the fibres of the deltoid muscle (Fig. 255, D). It is better to incise the deltoid than to pass between it and the pectoralis major, the cephalic vein and accompanying artery being thus uninjured. The wound is thoroughly opened up by means of retractors, and the bicipital groove looked for, an incision is made along its outer border, and the long tendon of the

biceps, if still present, turned out, and held to the inner side by a blunt hook. A twig of the anterior circumflex artery will here be divided, and need a ligature. The arm is now thoroughly everted, and the tendon of the subscapularis and the anterior part of the capsule, with which it is incorporated, freely divided, where practicable, the attachments of the muscle to the bone should be separated subperiosteally, a proceeding presenting no difficulty where inflammation has previously existed. The arm is now inverted and held downwards by the side of the table, so as to bring the great tuberosity into view, the muscles attached to this process are dealt with in a similar way, and the upper part of the capsule freely opened. The head of the bone is then protruded into the wound, and removed by the saw. It will often suffice to apply the saw obliquely through the substance of the tuberosity, this is to be preferred to removal of the whole tuberosity by a horizontal incision at a lower level. The synovial membrane and glenoid cavity are dealt with as circumstances may dictate, and it is often advisable to make a counter-opening through the posterior axillary fold for the

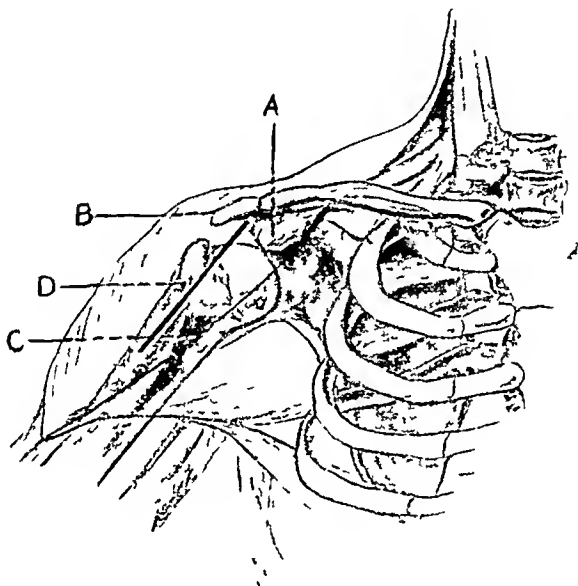


FIG 255.—INCISION FOR EXCISION OF SHOULDER

A, Coracoid process, B, tip of acromion, C, intermuscular line between deltoid and pectoralis major, D, incision

insertion of a drainage-tube, the anterior wound can then be entirely closed. In applying the dressing, care must be taken to put a good pad in the axilla, so as to keep the arm from being drawn forcibly inwards by the muscles attached to the bicipital groove. There is no need to commence passive movements before the end of the first week. Fibrous union usually results, and the movements of the shoulder are generally very good.

**Excision of the Elbow** may be required for simple or compound fracture-dislocation, or for subsequent ankylosis, especially if the limb is in a bad position, for tuberculous arthritis, and possibly in the later stages of acute arthritis. The best plan of operating is as follows. A single longitudinal incision, 5 inches in length is made in the middle line of the posterior aspect of the joint, extending for equal distances above and below the tip of the olecranon, and a little to the inner side. The limb is held across the patient's body, the surgeon standing on the affected side. The incision extends through the substance of the triceps down to the bone. The origin of the flexor carpi ulnaris and the inner half of the triceps

tendon are detached, and the hollow between the olecranon and the internal condyle cleared, the knife being kept close to the bone, and the soft parts retracted by a vigorous use of the thumb-nail. By this means the ulnar nerve escapes injury, and, indeed, is often not seen at all. The internal lateral ligament should be divided, and the common origin of the flexors from the front of the inner condyle. The outer half of the joint is then dealt with in a similar way, the anconeus being divided close to its insertion to the ulna, the continuity of the triceps with the deep fascia covering it being also maintained. The origin of the extensor muscles is separated from the back of the outer condyle, and the external lateral ligament severed. The joint can now be freely opened by dividing any of the fibres of the posterior ligament which remain intact, and the denuded ends of the bones protruded from the wound. The lower end of the humerus is

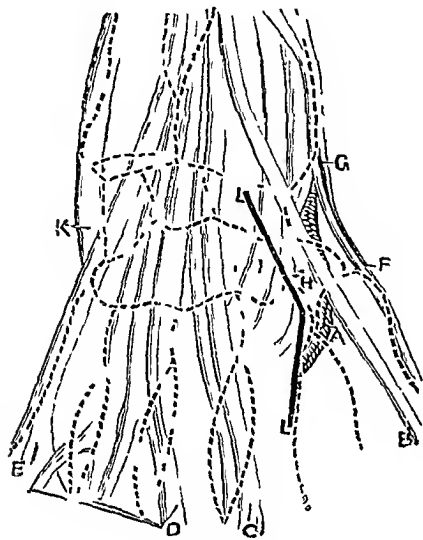


FIG 256 — EXCISION OF THE WRIST  
(LISTER)

A, Radial artery B, extensor secundus internodii pollicis C, ext indicis D, ext communis digitorum E, ext minimi digiti F, ext primi internodii pollicis G, ext ossis meta carpi pollicis H, ext carpi radialis longior I, ext carpi radialis brevior K, ext carpi ulnaris L, L, line of radial incision

within the grasp of which the upper limb is able to move

The Wrist-joint is only excised for extensive tuberculous disease when abscesses and sinuses are present. Ankylosis of the articulation, though a troublesome condition, is not sufficiently so to require such treatment. The best method to employ is that known as Lister's operation, a somewhat complicated proceeding, but which in suitable cases gives excellent results. Prior to operating the fingers are well bent, so as to break down any adhesions which are present. Two incisions are made, one on the radial side of the dorsum, and the other on the inner or ulnar aspect of the wrist. The dorsal incision is angular (Fig 256, L, L), commencing at a point on the back of the radius between the tendons of the extensor secundus internodii pollicis (B) and the extensor communis digitorum (D), it is at first parallel to the former tendon, and on its ulnar side, till it reaches

now thoroughly cleared, and the articular surface removed, the section passing through the centre of the olecranon fossa. The olecranon, together with the upper articular surface of the coronoid process and the head of the radius, are next sawn off, care being taken to draw aside and protect the soft parts by retractors, especially those covering the ulnar nerve. The synovial membrane can be dealt with as may be necessary. Even if the head of the radius is free from disease, nothing is gained by leaving it intact, since ankylosis is very likely to follow unless plenty of bone is removed. As a general rule, a gap of  $2\frac{1}{2}$  inches should intervene between the divided ends of the bones. For a similar reason subperiosteal resection is needless, and, indeed, is an undesirable refinement. The wound is carefully sutured, and a drainage-tube inserted for a few hours. The limb is kept on a hinged angular splint for a week, by which time union of the external wound should be complete, but the position is altered each day. After a week, the splint may be dispensed with, and the limb kept at rest on a pillow, free passive movement, both angular and rotatory, being daily practised. Considerable attention is needed in order to obtain a good result, but in a successful case every movement of the joint is perfectly restored. As a rule, the lower end of the humerus develops two lateral bony processes, like malleoli, rounded ends of the radius and ulna are

the base of the second metacarpal bone, when its direction is changed, and it courses downwards along that bone for an inch or two. It should extend to the bone, and in doing so the tendons of the extensor carpi ulnaris longior and brevis (H and I) are divided as close to their attachments as possible. The tendinous structures are then stripped off the back of the dorsum on either side of the incision, and on the outer side a pair of cutting pliers is insinuated so as to detach the trapezium from the rest of the carpus. The synovial sheaths of these tendons should, if possible, not be opened. The hand is then rolled over, and the ulnar incision made well on the inner side of the limb, extending for at least 3 inches between the extensor and flexor carpi ulnaris tendons. The separation of the extensor tendons from the back of the carpus is now completed, and the attachment of the extensor carpi ulnaris (K) divided. The tissues on the palmar aspect of the joint are detached, the pisiform being severed from the rest of the carpus, and where possible left, and the hook of the ulniform clipped off with cutting pliers. The carpus is now free front and back, and the bones are either removed piecemeal or taken away *en bloc* by inserting a pair of cutting pliers above and below, and dividing their upper and lower connections, more usually the carpal bones are picked out in fragments. Attention is then directed to the lower ends of the radius and ulna, and to the articular ends of the metacarpal bones, all the cartilage and the intervening synovial tissue being cleared away. Finally, the remaining fragments of the carpus are dealt with as the case may require. The radial incision may often be entirely closed, whilst a drainage-tube is inserted through the ulnar wound. The hand is placed on a special splint, with a thick convex cork support for the palm, which keeps the wrist slightly extended, and with a short lateral projection upon which the thumb can rest. The fingers must be thoroughly flexed and extended daily, beginning on the second or third day, but the wrist should be kept at rest until it is quite firm. There is a much greater tendency to a flail-like joint than to undue fixity, owing to the amount of bone removed, and the necessary division of all the extensors of the carpus, if such occurs, a leather support must be worn, either as a temporary or permanent appliance.

The **Hip-joint** is rarely excised for conditions other than tuberculous disease, and even for this it is performed much less frequently than formerly. There are two chief methods of operating, the anterior and the posterior.

1. Excision by the *anterior method* is carried out as follows. The incision (Fig 90, D, p 336) extends from immediately below the anterior superior spine vertically downwards for 3 or 4 inches. It passes between the tensor fasciæ femoris and sartorius muscles superficially, and between the glutei and rectus deeply. A small articular twig from the external circumflex being divided at this stage. The neck of the bone and capsule of the joint are exposed, and the latter is freely incised along its attachment to the anterior inter-trochanteric line, so as to allow of the admission of the finger, whereby the joint can be fully explored. The neck of the bone is cut through *in situ* by means of an Adams' osteotomy saw, the incision through the bone being placed obliquely downwards and inwards. The head of the bone is now either prised out of the acetabulum by an elevator, or grasped by lion forceps and twisted out, a matter easily accomplished where the articular structures are diseased, but a proceeding of some difficulty in the normal joint of a cadaver. As much of the infected synovial membrane as possible is clipped away with scissors, and the acetabulum scraped, if necessary. The external wound is either closed, with the exception of an opening for a drainage-tube, or stuffed with gauze soaked in iodoform emulsion. There may be comparatively little shortening of the limb as the result of this proceeding, but the movements are considerably limited.

2. Excision by the *posterior method*, as we have already said, is usually undertaken in the later stages of the disease. Any sinuses which exist posteriorly may be utilized, but if the skin is unbroken, an incision known as Langenbeck's may be employed (Fig 257). The patient lies on the sound limb, whilst the affected thigh is flexed. The incision is made in the line of the femur, extending 2 inches above the top of the great trochanter, and about 3 inches below it. It is carried at once down to the bone, and the muscles attached to the summit and posterior border of the great trochanter freely divided, as close to the bone as possible.



The capsule is opened to a sufficient extent to allow of the exploration of the joint by the finger. If the disease is very extensive, the femur is now chiselled across, immediately below the great trochanter, but above the lesser. The upper end of the bone is grasped by lion forceps and twisted out of the acetabulum, after division of the remaining structures, which are attached chiefly along its anterior border. The ligamentum teres has almost always been previously destroyed and hence this stage of the operation is not especially difficult. The synovial membrane and acetabulum are easily reached, and the diseased portions removed. In favourable cases a drainage tube may be inserted, and the wound closed, but not uncommonly it is wiser to partially stuff it with gauze infiltrated with iodoform, and allow it to heal by granulation. Slight extension of the limb should be subsequently made, so as to prevent undue shortening from the traction of the long thigh muscles. The leg is placed between sand-bags or a Liston's long splint applied. Fibrous ankylosis, with a certain limited amount of movement, is the usual result.

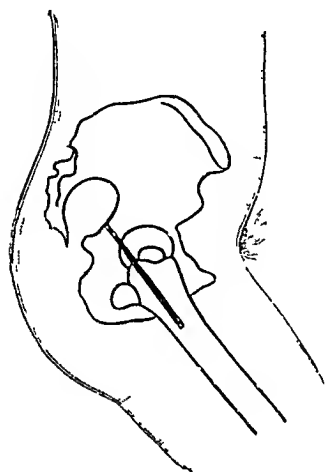


FIG 257 —LANGENBECK'S  
INCISION FOR EXCISION OF  
THE HIP FROM BEHIND  
(TILLMANN'S)

It is not always necessary to include the trochanter in this operation. If the disease is limited to the head of the bone, it alone should be removed, with as little disturbance as possible to the muscles passing to the trochanter. If such can be effected, the subsequent mobility and usefulness of the limb are considerably increased.

The advantages claimed for the anterior method are that it is a less severe operation, that fewer muscles and tendons are interfered with, that no vessels of importance are divided, and that only the head of the bone is excised. The objections to it are that the drainage provided is very unsatisfactory, that the trochanter cannot be readily dealt with, whilst it is also difficult to remove all the synovial membrane.

The great advantages of the posterior operation are that in spite of a free division of the muscular and tendinous attachments, excellent drainage is provided, and both trochanter and acetabulum are readily accessible. On the whole, the anterior method should be employed in the early stages of the disease, the posterior in the later. The situation of abscesses or sinuses may, however, determine the choice of the surgeon.

The Knee-joint is excised for tuberculous disease, osteo arthritis, or deformity due to osseous or fibrous ankylosis in a bad position. A horseshoe shaped incision is made, extending from the back of one condyle to the other, reaching downwards nearly as far as the tubercle of the tibia. The limb is well flexed, the ligamentum patellæ divided, and the joint opened. The skin and subcutaneous tissues are then separated from the anterior surface of the patella, which may be at once removed by a curved incision above it, communicating on either side with that already made below, the subcrural pouch of synovial membrane being also removed during this dissection. The flexion is now increased, and the lateral ligaments divided. By this means the interior of the joint is freely exposed, so that the attachments of the crucial ligaments to the tibia can also be severed. The lower end of the femur is then cleared of diseased synovial membrane so as to allow of the application of a broad excision saw. The usual rule given as to the direction of the saw cut in the bone is that the exposed bony surface left after removing its articular end should be absolutely horizontal, supposing the patient to be standing upright. Personally, we prefer to make the sections so that the limb shall be left very slightly flexed and in kneed, a position which greatly adds to the subsequent comfort of the patient. To accomplish this the saw must be applied parallel to the articular surface, at right angles to the axis of the body not of the femur, and with a slight upward slant from before backwards. The bone should be partially sawn through by a side

to side movement but the posterior surface of the condyles should be divided by raising or depressing the handle of the instrument, so that the structures lying behind in the intercondylar notch are not encroached upon. Sufficient bone should be sawn off in the adult to include the greater part of the articular cartilage but as little as possible consistent with removing all the disease, otherwise the limb is shortened to such an extent as to interfere with its subsequent usefulness. The head of the tibia is then protruded, and cleared from the neighbouring soft parts: it is held absolutely vertical, and a saw applied in a horizontal position, the bone being divided from before backwards. Any diseased synovial membrane is now dissected away, special attention being directed to the posterior aspect of the joint. All bleeding points having been secured by ligature the bones are fitted together, and if considered advisable, secured in position by thick silver wire or silver plated nails or screws. The external incision is closed drainage tubes being inserted at each angle of the wound, if need be. A Gooch's splint is applied to the limb and in this it remains until sound healing has occurred after which in immovable case either of plaster of Paris or water-glass is kept on until eight or ten weeks have elapsed since the operation.

The Ankle-joint is excised for tuberculous disease. Two incisions are made an inner and an outer. The outer incision runs along the anterior border of the fibula and curves round the outer malleolus being about 3 inches in length. The lower end of the fibula is exposed and by preference subperiosteally. The external lateral ligament is split vertically, and separated from its attachments to the fibula its continuity with the periosteum being however maintained. The fibula is then divided about 1 inch above the tip of the malleolus and the latter process of bone removed. The periosteum and ligaments are separated as far as possible from the front and back of the bones. The inner incision is T shaped and is made along the inner surface of the tibia with a short transverse cut at its lower end which reaches just below the inner malleolus. The periosteum and internal lateral ligament are dealt with as on the outer side and the front and back of the tibia are easily denuded. The inner malleolus is projected from the wound and the lower end of the tibia removed by a keyhole saw the dorsal structures being held aside by a retractor. The articular surface of the astragalus is sawn off from the outer wound, or if advisable, the whole of the bone may be removed.

The above subperiosteal method of excision is one of the best that have been suggested. The greatest care should be taken not to open the sheaths of the tendons and in dressing the wound the foot must be kept at right angles to the leg, and no lateral deviation permitted. As soon as possible it is encased in plaster of Paris, windows being left for the dressing of the wounds, if necessary.

In non-tuberculous cases a transverse incision extending from one malleolus to the other may be employed. Sutures are placed through the tendons above and below, and they are then divided. The anterior tibial nerve is similarly secured above and below before division and the vessels are divided between ligatures. By opening the capsule a very free exposure of the joint surfaces is provided permitting a very thorough excision. The divided tendons and nerve are carefully sutured together before closing the wound.

Excision of the Astragalus is sometimes required in the treatment of tuberculous disease of contiguous joints as also in some cases of talipes and of fractures or dislocations of the bone. Many methods of operating have been described but we think it is best accomplished through a single vertical incision over the front of the ankle running parallel to the vessels and tendons which are carefully avoided and stripped back from the dorsum by means of periosteal detachments so that the upper surface of the astragalus can readily be reached. The astragalo-scapoid joint and ankle are then freely opened and the ligamentous and fascial connections on either side severed. The neck of the bone may with advantage be divided at this stage, and its head removed, so as to give access to the under surface and allow of the division of the strong interosseous ligament extending between the adjacent surfaces of the astragalus and os calcis. It may be possible to remove the rest of the bone in one fragment, but it is certainly wiser to break it up with chisel or gouge, and take it away piecemeal.

## CHAPTER XXIII

### INJURIES OF THE SPINE

THE spinal cord is protected from injury in a most complete and efficacious manner (a) Its position between the bodies and the laminæ with the spinous processes arising therefrom is itself mechanically advantageous, since, whether the spine is forcibly flexed or extended, the cord remains midway between the points of chief compression or extension, and hence in a position of rest (b) The buffer-like action of the intervertebral discs, and the varying curves of the column, serve to distribute some part of any force that reaches it (c) There is ample space in the medullary canal, in which the cord with its membranes is slung by prolongations of dura mater around the issuing nerves, whilst the cord itself hangs loosely within the dura mater, suspended by the ligamenta denticulata, and surrounded by cerebro-spinal fluid (d) The cord terminates, in an adult, at the lower border of the first lumbar vertebra, a spot well above the junction of the fixed base and the moveable upper part, a point where the effect of jars and wrenches is mainly felt (e) Nature has, moreover, introduced a whole series of buffers and other means of preventing shock to the spine when a person falls on his feet, *e g*, the arches and elasticity of the foot, the changes in direction of the bones at each joint, the inter-articular cartilages of the knee, etc

The parts of the spine most exposed to injury are those where a fixed and moveable portion meet, *e g*, the dorsi-lumbar and the cervico-dorsal regions. The upper part of the dorsal curve, which is relatively weak and projects backwards, is thereby exposed to injury, so that fractures are not at all uncommon about the fourth dorsal vertebra. The close proximity of the head explains the frequency of lesions about the upper cervical region

#### Sprains

Sprains and strains of the spine are very common accidents, a fact not to be wondered at, when we consider the complicated muscular and ligamentous arrangements present. They are produced by any sudden or unexpected movements, such as falls, especially from horse-

back, railway accidents, and the like. The injury is most likely to affect mobile parts of the spine, *e.g.*, the cervical and lumbar regions, and may be limited to the ligamentous or muscular structures, or may involve both. The resulting **Signs** are simply those of a severe but localized trauma, *viz.*, pain, tenderness, bruising, and perhaps a little swelling, the subjective phenomena are much increased by movement, so that the spine is always kept rigidly quiet. If only the muscles or interspinous ligaments are involved, no further consequences are likely to arise, but when the ligamenta subflava are lacerated and the spinal canal is thus opened, the gravest symptoms may ensue from blood finding its way into the canal outside the dura mater, leading possibly to paraplegia, which may be of a temporary or permanent nature. Inflammation of the damaged fibrous tissues may also extend to the meninges and cord, and cause compression of the latter or even organic disease. Moreover, in patients of a tuberculous temperament, spinal caries may be set up as a result of such injuries, whilst syphilitic or malignant disease has also been known to follow.

In the *cervical* region, sprains are very liable to occur as a result of severe blows on the head, causing rupture of the inter-transverse ligaments, and the displacement may be so great as to simulate dislocation. The head and neck are held immovable and rigid, and there is often considerable loss of power, the patient being sometimes unable to lift the head spontaneously from the pillow. Sprains in the *lumbar* region are very common, both as a result of railway injuries, when they are often associated with nervous symptoms (p. 713), and as a consequence of overlifting, when the quadratus lumborum is most likely to be affected. The back is kept fixed and rigid, the patient being unable to turn or stoop without pain. Sometimes hæmaturia results from injuries in the lumbar region, arising from an associated contusion of the kidneys.

**Treatment** —The patient should be kept at rest, and fomentations applied to the injured part. When the painful or inflammatory symptoms have disappeared, massage with stimulating liniments is needed. In the severer cases the individual should be kept in bed for six or eight weeks, and in the cervical region some form of mechanical support may be subsequently necessary. The appearance of inflammatory symptoms involving the meninges calls for greater care, the patient should then be kept as much as possible in the prone position, and a spinal icebag applied. The onset of paraplegia, due either to hæmorrhage or inflammatory exudation, would raise the question of laminectomy (p. 717).

### Penetrating Wounds of the Spine

These lesions are, fortunately, uncommon in civil practice, being generally due to stabs with pointed instruments, such as bayonets, or to gunshot wounds. They occasionally result from falls, the unfortunate individual becoming impaled on area railings, branches

of trees, etc. The **Symptoms** produced are (a) those due to the wound in the soft parts, which may also involve the peritoneal and pleural cavities, or damage some of the viscera, in the neck, the vertebral artery is exposed to injury from this type of accident, leading to serious hæmorrhage, (b) various forms of fracture, the cord being compressed by fragments of bone which have been driven inwards, or by extravasated blood, (c) those due to laying open the spinal membranes, *e g*, loss of cerebro-spinal fluid, which in itself might prove fatal by draining the cerebral cavity, and so causing pressure on the base of the brain, or at a later date may determine the patient's death by setting up diffuse septic meningitis (p 712), and (d) those due to wounds of the spinal cord. The effects of a total transverse lesion at different levels of the spine are given at p 715, even if the patient escapes the dangers of diffuse septic meningitis, he will later on develop acute myelitis. Of course, the division of the cord may be only partial, or it may escape entirely, whilst nerve roots or trunks may be involved, and in the lumbar or sacral regions the cauda equina may be divided.

**Treatment** consists in thoroughly exploring the wound under an anæsthetic, removing foreign bodies or displaced fragments of bone, and attempting to render it aseptic. Wounds of the vertebral artery or other structures are dealt with *secundum artem*, and special attention is naturally given to the cord and its membranes. Should the dura mater have been opened, and the cord have escaped injury, an attempt may be made to close the wound in the meninges, and the patient should subsequently be kept in the prone position and with the head low, so as to prevent, as far as possible, the escape of cerebro-spinal fluid. If the cord itself is divided or lacerated, it is useless trying to unite it, since its function in conducting impulses from the brain downwards is inevitably destroyed. Where, however, the cauda equina has been injured, it is perfectly justifiable to lay open the spinal canal to a sufficient extent to expose the divided nerve trunks, and then to suture them.

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### Fractures of the Spine

**Causes**—The spine may be broken as the result of (a) *direct violence*, *e g*, a fall on the back over some projecting body, such as a carpenter's bench or a railing, or a blow on the back with a heavy stone or with a swinging baulk of wood, or a gunshot wound. This type of accident may involve any part of the spine, and, excluding those arising from gunshot, is less frequent than the class next to be described. Of necessity, the spine breaks at the point struck, the posterior parts of the vertebræ are most likely to be damaged in this form of injury. (b) Fractures are also due to *indirect violence*, then usually occurring in the lower cervical or upper dorsal regions. They are caused by forcible flexion of the spine, as by a fall downstairs with the head doubled up, or by taking a 'header' into shallow water, or when a man, being driven under a bridge, omits to stoop,

and so is caught between the arch and the cart, or sometimes by the fall of a heavy weight on the back of the neck, the spine bending and breaking at the weakest spot

Fractures of the spine may be divided into two main classes, according to whether or not they are complete—that is, according to whether the continuity of the column is destroyed or not

(A) **Incomplete Fractures** may be met with in various forms, and are most frequently due to direct violence

(i) *Fractures of the Spinous Processes* rarely occur except in the lower cervical or dorsal regions. In the upper cervical region the spines are short and retracted to allow of extension of the head, whilst in the lumbar they are also short, but very strong. The fracture is almost always due to direct violence, and is characterized by the signs of a local trauma, together with great mobility, perhaps crepitus, and irregularity in the line of the spines. The process is occasionally much depressed, and may even cause paraplegia by being driven into the spinal canal

(ii) *Fracture of the Laminae* is a not uncommon accident, always resulting from direct violence. If only one lamina is broken, the signs are not very distinct, and cord symptoms are rare. When both laminae yield, the posterior part of the neural arch, carrying with it the spinous process, is very likely to be depressed to a sufficient extent to compress the cord and give rise to paraplegia. Crepitus is often obtainable, and a gap in the line of the spinous processes can usually be felt

(iii) *Fracture of the Transverse Processes* is but rarely met with apart from other lesions of the spine

(iv) *Partial Fracture* through the bodies may occur in the form of fissures, which produce but little effect, except pain and rigidity, and cannot be diagnosed with certainty

Even in fractures where displacement is not present, paraplegic symptoms may arise, either immediately from concussion of the spinal cord, or later on from the pressure of hæmorrhagic or inflammatory effusions

The **Treatment** merely consists in keeping the patient at rest for a time. The question of laminectomy for paraplegia, due either to displacement of the laminae or to hæmorrhage, will be discussed later (p 717)

(B) **Complete Fractures** are usually associated with displacement, and loss of continuity of the spinal column, and hence are often termed **Fracture Dislocations**. They result either from direct or indirect violence. There is always a tolerably extensive lesion (Fig 258), thus, the spinous processes and laminae may or may not be fractured, the ligamenta interspinosa, supraspinosa, and subflava torn, the articular processes fractured in the lumbar and dorsal regions, or displaced without fracture in the cervical, and either the intervertebral substance torn across, or the bodies broken, thus severing the spine into two halves. The upper or moveable portion is usually driven forwards over the lower or more fixed fragment, and

impaction or comminution is often present. The spinal cord is compressed between the upper end of the lower fragment and the laminae of the upper fragment, and although the displacement may be naturally remedied by the falling back of the bones into position ('recoil'), yet the effects of the crush on the cord are usually irremediable. In slighter cases the spinal membranes may be merely punctured by a splinter of bone, or hæmorrhage may occur either within the membranes, or outside them in the fatty theca vertebralis. Excessive indirect violence may lead to an associated fracture of the sternum.



FIG. 258 — COMPLETE FRACTURE DISLOCATION OF THE SPINE IN THE LOWER DORSAL REGION WITH DISPLACEMENT AND COMPRESSION OF THE CORD (AFTER KEEN AND WHITE)

The Signs of a complete fracture are usually very evident, consisting of local pain, swelling, and bruising, and a certain amount of angular deformity, more or less according to circumstances. It may be possible to elicit crepitus, if the parts are not impacted, but all unnecessary movement should be avoided for fear of adding to the injury of the cord. Paraplegia below the part injured is present in most cases, and with it some amount of general shock. When the cord is disintegrated or divided, symptoms of spinal myelitis rapidly follow, and a fatal issue often occurs at an early date from toxæmia following septic cystitis or sloughing of the nates. The special phenomena of paraplegia are dealt with at p. 714.

The Prognosis of these cases turns largely on the situation of the injury and the amount of mischief sustained by the cord. The higher the lesion, the greater the danger, although patients with paraplegia from cervical fracture may live for years, and even partially recover, if the cord has not been totally disintegrated.

The Treatment naturally varies with the character of the case. The patient is carefully placed on a prepared bed, the greatest gentleness being used in handling and lifting him, for fear of increasing the damage to the cord. The bed must be firm, though not hard, perhaps the best type to employ is a horsehair mattress placed over fracture-boards, nothing more soft or yielding is permissible. Spring beds and wire-wove mattresses are most undesirable. A water-bed is required in the later stages, but should not be used at first, as it is

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scarcely firm enough The shock resulting from the accident is treated in the usual way by warmth and, if need be, by stimulants, but it must be remembered that anæsthetic regions of the body can be easily blistered or burnt by hot-water bottles, unless carefully guarded by flannels When reaction has occurred, a more thorough examination of the patient can be made, and the subsequent course of action decided on

(a) In a small minority of the cases *operative treatment* is justifiable We shall discuss later on (p 717) the indications for laminectomy

(b) When the displacement persists owing to impaction of the fragments, *reduction* under an anæsthetic may possibly be undertaken, provided that the lesion is not in the cervical region, and the paraplegia not complete Of course, if other internal injuries are present which render the case hopeless, nothing should be done Great care must be used in attempting reduction, since the object is to relieve pressure on the cord, and any undue violence may readily increase the mischief, in the lumbar region, however, considerable force may be employed without much danger Whether reduction is accomplished or not, the further treatment must be directed in accordance with the indications given in the next paragraph Where the surgeon fails to reduce the deformity, it may sometimes be advisable to make gradual extension from the feet or neck by the use of weight and pulley

(c) In many cases, as soon as the patient is laid flat on a bed, the displacement remedies itself, especially if the spine has been comminuted, and then the treatment must be *symptomatic*, as also after reduction or operation, where the paraplegia persists or is only slowly recovered from He is kept in bed, absolutely flat, and with the head low, perhaps some form of mechanical support, *e.g.*, a plaster of Paris or leather jacket, may be considered advisable, but its application is always a matter of difficulty, and in the early stages it does but little good Food is regularly administered, and at first must be light and readily assimilable

The chief care of the attendants must be directed to the skin, bladder, and bowels *Bedsores* are extremely liable to form on all points of pressure, and hence the nates and heels must be carefully guarded (p 107) In turning the patient to attend to the nates, the body must be rolled over as a whole, and not merely the pelvis twisted It will often be found advisable to have a divided mattress placed beneath the pelvis, so that one lateral segment may be removed at a time, and thus rotation of the body will not be needed A bedpan can also be used in this way without disturbing the spine When the *bladder* is paralyzed, the urine must be withdrawn by a catheter One of the greatest dangers that the patient runs is from the super-vention of septic cystitis, and the extension of the inflammation upwards to the kidneys This is always due to infection from without, and the greatest care must be taken to prevent it The penis should be thoroughly purified, and the urethra well flushed out before passing an instrument in these cases, in the intervals between instrumentation the penis is wrapped in a dry sterile dressing Only soft rubber



catheters are employed, and these must be kept absolutely aseptic by immersion in 5 per cent carbolic lotion, or 1 in 1000 sublimate, which is subsequently removed before use by washing with a solution of boric acid. Should sepsis occur, the bladder is irrigated twice daily with some mild antiseptic, such as Condy's fluid, boric acid, boro-glyceride (1 in 20), or sanitas (1 in 20), whilst urotropine, salol or boric acid in 10-grain doses may be administered by the mouth thrice daily. Probably, in spite of all precautions, the condition will persist, and prove fatal from extension to the kidneys. The *bowels* are always obstinately constipated, and must be opened either by purgatives or simple enemata.

Under such a régime the patient may gradually recover, but more often succumbs to septic poisoning or exhaustion. Occasionally he may live for a long time, although paralyzed, possibly developing some amount of reflex micturition, if the lumbar centres are not involved. Varying degrees of restoration of power in the lower limbs are also met with.

### Dislocations of the Spine

By dislocation of the spine is meant a displacement forwards, either partial or complete, of the upper part of the spine, with separation of the articular processes, and tearing of the intervertebral substance. A pure dislocation can only occur in the cervical region, and even then it is not uncommonly associated with a fracture. The reason for this depends partly on the immobility of the dorsal and lumbar vertebræ in the latter regions, and partly on the direction of their articular processes. In the cervical region these look mainly upwards and downwards, with a slight slope forwards and backwards, so that it is not difficult for one to slip over the other, in the dorsal region they are placed nearly vertical, looking forwards and backwards, whilst in the lumbar they are also vertical, but look inwards and outwards, the lower enclosing the upper as in a sheath, so that in the last two regions of the spine dislocation is impossible without concurrent fracture of the articular processes and probably of the laminae.

Any part of the cervical region may be the seat of a dislocation. The *occiput* has been displaced from the *atlas* in a few cases, resulting in sudden death, but if incomplete, life has been prolonged for a few hours or days. Dislocation of the *atlas from the axis* has followed blows on the neck, or has been the cause of death in hanging, whilst the attempt to lift a struggling child by the head has sometimes led to this calamity. In almost all cases the odontoid process has been fractured or the transverse ligament torn, causing instant death from compression of the cord, owing to the head and atlas slipping forwards. Lateral displacement from rotation has also been observed, the cord symptoms then being of a milder type.

Dislocation may occur between any two of the *lower five cervical vertebræ*, but perhaps most frequently between the fifth and sixth. It is almost invariably the result of forcible flexion of the head and neck,

perhaps combined with rotation, and as a rule the intervertebral articulations are torn open, whilst the supraspinous and interspinous ligaments, the ligamenta subflava, and the anterior and posterior common ligaments, are lacerated, and the intervertebral substance torn across, or a scale of the articular surface detached. The head and upper portion of the spine are displaced forwards, so that the cartilaginous surfaces of the articular processes of the lower vertebra project behind the laminae and transverse processes of the upper, and the lower articular processes of the upper vertebra lie within the intervertebral notch of the lower bone (Fig 259, A and B, *a*). Two forms of dislocation are met with—the unilateral and bilateral

(*a*) **Unilateral Dislocation** of the cervical spine is due to force applied from the back and side of the neck. The head is turned towards the opposite side, and more or less fixed, whilst there is no evidence of compression of the cord, although a tingling and neuralgic pain along the course of the nerves may arise from pressure upon and stretching of the nerve roots in the intervertebral notch. The spinous processes may be irregular and displaced laterally, whilst the line of

the transverse processes is similarly altered, such signs are, however, very difficult to make out in thick necks. If left unreduced, the vertebra becomes fixed in its new position, the head and neck displaced, and permanent neuralgia may result. In such cases, if seen early, *replacement* may be attempted. The patient is anaesthetized, the body fixed, the head and neck flexed, and traction made in that position, so as to unlock the edges of the articular processes. Reduction may be accomplished with a definite snap or catch. In old-standing cases an operation may sometimes be attempted to relieve pressure on the nerves, but it is impossible to replace the bones.

(*b*) **Bilateral Dislocation** (Fig 259, A and B), if complete, is always accompanied with pressure upon the cord and paraplegia, occasion-

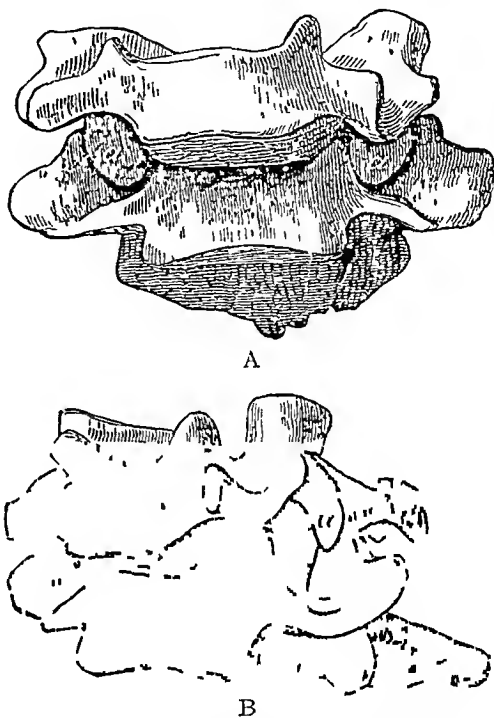


FIG 259 — DISLOCATION OF THE CERVICAL SPINE (AFTER KEEN AND WHITE)

A As seen from in front B side-view  
*a, a* indicate the lower articular facets of the upper or displaced vertebra, which are thus seen to lie in front of the upper articular processes of the lower vertebra

ally, however, it is only partial, and then the cord may escape without immediate injury, owing to the large size of the canal in this region, hæmorrhage and inflammation may subsequently cause grave symptoms. **Treatment** is of but little avail in most of the cases of complete double dislocation, since probably the cord is irretrievably damaged, but where paraplegia is incomplete it is possible that benefit may arise from early interference. Replacement by traction on the head with the neck flexed may be first carefully tried, and failing that laminectomy should be performed. After stripping the muscles from the bones, the surgeon will see the two cartilage-covered surfaces of the upper articular processes of the lower vertebra standing out clearly behind the laminæ of the displaced bone. Upward traction on the head may now again be made, and reduction thus attempted, but if this does not succeed, as small a portion as possible of the upper margins of the exposed articular processes is excised in order to allow of the unlocking of the bones, if the whole processes are removed, reduction is much easier, but Nature's barrier to prevent a recurrence of the trouble has been taken away, and fixation of the spinal column in its natural position becomes impossible. The sudden relief of pressure not uncommonly causes such an interference with the intravascular tension in the cervical cord as to lead to a temporary cessation of the breathing, for which artificial respiration is required. It is usually advisable not only to replace the bones, but also to open the spinal canal and membranes, so as to remove any pressure of blood or inflammatory exudation which may exist. The results of such operations are not particularly satisfactory.

### Secondary Effects following Spinal Injuries

Injuries of the spinal column are frequently associated with, or followed by conditions affecting the cord and its membranes which may lead to the gravest results, even when the local lesion to the spine has been comparatively slight. These are frequently combined with one another in the most puzzling fashion, so that it is often difficult to state the exact nature of a certain group of symptoms. For simplicity's sake we shall discuss them here without attempting to describe the various combinations which may present themselves.

The following secondary effects may be met with after spinal injuries: (a) Direct spinal concussion, (b) spinal hæmorrhage, (c) spinal meningitis, (d) spinal myelitis, and (e) spinal neurasthenia (or railway spine).

**Direct Concussion**—This condition may be due to severe blows in the back, which do but little damage to the spinal column, or may be caused by accidents which lead to the infliction of greater mischief, but without any serious displacement of parts. The term 'concussion' should be limited to those cases *where energetic traumatic influences (falls, blows, collisions, etc.) have given rise to severe disturbance of the functions of the cord without any considerable visible anatomical changes in the latter* (Erb). In fact, the term is really only applicable to those cases which recover more or less completely. If recovery does not ensue, minute extravasations or other lesions have been present, constituting a condition of contusion rather than concussion. It is somewhat doubtful, however, whether all these cases are not due to minute hæmorrhages.

The *Symptoms* produced are those of a more or less complete and immediate loss of function of that portion of the cord situated below the point struck. Thus, a varying degree of paraplegia is produced, the signs of which differ with the region affected (see p 715). In addition, the patient is usually prostrate

from general shock to the system, and the reflexes are often totally lost—at any rate, for a time. Death may be caused at once by a blow in the upper cervical region, or varying degrees of loss of power and sensation may be produced in any or all of the limbs. In the lower cervical region the arms are mainly affected and perhaps some particular nerve may be picked out and paralyzed. In the lumbar and dorsal regions a more typical paraplegia is produced, with loss of power over the sphincters and loss of reflexes. Priapism never occurs in simple concussion. The temperature of the body may be depressed, and the extremities pallid and cold; the pulse is rapid and weak, and the respirations shallow.

The *Prognosis* is always uncertain, as in cases where there is no displacement it is impossible to gauge the extent of the mischief. If merely concussion is present, the patient is likely to recover, if the cord is contused or hæmorrhage has occurred into it, a perfect recovery can scarcely be expected.

In the *Treatment*, absolute rest to the spine is of the greatest importance, and this should be maintained if possible in the prone position so as not only to diminish static congestion, but also to remove any pressure on the spine and to allow topical applications to be made. A spinal icebag may be applied, or the back may be dry-cupped whilst the patient is kept absolutely still, and on a low diet. The bladder and bowels need attention but no special drugs are necessary. Of course local injuries require suitable treatment.

**Spinal Hæmorrhage**—We can here only discuss the subject of spinal hæmorrhage as resulting from injuries. It also occurs apart from traumatism and it is interesting to note that such happens more frequently in young persons between the ages of ten and twenty than in old people as with cerebral hæmorrhage. The bleeding may take place either into the cord itself or outside it and hence the two following varieties are described.

(a) **Intramedullary Hæmorrhage** or spinal apoplexy (*hæmatomyelia*) is met with as a result of injury which need not necessarily involve the spinal column; the lower cervical region is the part usually affected and the type of accident some form of acute flexion. Extravasation into the cord is rarely extensive and may occur in the form of one clot usually not larger than an almond, or more commonly in many spots, the gray matter being more or less ploughed up. The white matter is compressed and sometimes the blood bursts through it into the membranes. Should the patient survive the injury for any length of time, secondary degenerations are established and run the usual course. The patient is suddenly struck down with a more or less complete paraplegia and with perhaps pain in the back shooting round to the chest and followed by a rapid rise in temperature. Some degree of recovery follows especially in the legs, but the parts supplied from the damaged portion of gray matter—the arms—are likely to remain paralyzed. In slighter cases only involving the gray matter the arms alone may show signs of paralysis from the first. The *Diagnosis* of hæmorrhage turns on the rapid onset of paraplegia, which may be incomplete, without spinal irritation; fever may ensue for a few days, and if the cervical region is affected extreme contraction of the pupil (myosis) may result from destruction of the cilio spinal centre. The *Prognosis* depends on the size and situation of the clot; a large clot producing more injury than a small one; hæmorrhage in the cervical region may be immediately fatal by interference with the respiration whilst in the lumbar region it is unfavourable on account of the effect upon the sphincter centres. The outlook is best when the dorsal portion of the cord is affected. The *Treatment* is the same as was indicated for direct concussion, whilst the administration of ergot may be beneficial.

(b) **Extramedullary Hæmorrhage** (*hæmatocœlis*) is a more frequent complication of spinal injuries, such as sprains or limited fractures than the former. The blood is usually extravasated between the bones and the dura mater, especially in the cervical region but may occasionally be found within the dura, having trickled down from the upper part of the column. The symptoms are, in brief, those of spinal irritation e.g. pain, hyperæsthesia, spasms, cramps etc., rapidly followed by loss of power in the muscles supplied from the damaged area or by 'gravitation paraplegia' (Thorburn) which gradually extends from below upwards causing death by asphyxia, the whole series of phenomena being afebrile. In

intramedullary hæmorrhage the symptoms of paralysis are more evident, and those of spinal irritation less marked. If a diagnosis can be made, ergotin may be injected, and ice applied to the spine, or even laminectomy performed to relieve pressure. Later on, prolonged rest may cause the absorption of the clot, and even total restoration to health.

**Spinal Meningitis**—Inflammatory conditions of the spinal membranes may spread downwards from the head, or commence as a local affection. Two forms are met with resulting from injury.

(a) In **Acute Spinal Meningitis** the inflammation mainly affects the arachnoid and pia mater (leptomeningitis). It is usually generalized in distribution, and not unfrequently extends to the cerebral membranes. It occasionally follows simple injuries, but is always infective in origin. *Pathologically*, it is evidenced by hyperæmia and loss of polish of all the membranes, with an abundant exudation, later on, lymph or even pus may collect, especially about the posterior surface of the cord, should the patient live, organization of the effused lymph may lead to extensive adhesions. *Clinically*, the disease is usually ushered in by a rigor, especially in the septic cases, and then runs a marked pyrexial course. The symptoms are pain in the back, deep seated, boring, and severe, increased on all movements and often extending down the limbs or around the body, rigidity of the spine and limbs, accompanied by painful cramps and muscular spasms, almost simulating tetanic convulsions, extreme hyperæsthesia, especially of the legs, and increased reflex excitability, whilst rapid emaciation from pain and sleeplessness is soon produced. If the condition is limited to the spine, it is probably followed by signs of myelitis, viz., paraplegia, together with bedsores and vesical troubles, and these may lead to a fatal issue. Cases, however, are met with which pass into a chronic state, and may more or less recover. If the process also involves the cerebral membranes, as in septic cases, the symptoms of diffuse cerebral meningitis are also present, and the patient dies of coma. *Treatment* in the cases due to a penetrating injury is of no avail if prevention of the disease by asepsis fails. In simple cases an icebag should be applied to the spine, the patient remaining in the prone position. Ergot and belladonna may be given internally, and general measures to allay inflammation adopted. The bladder and rectum must be attended to, and bromides and chloral administered to gain sleep.

(b) **Chronic Meningitis** is usually localized, and may occur either as an inflammation of the arachnoid and pia mater (leptomeningitis), or be mainly limited to the dura mater (pachymeningitis). It either originates as a chronic affection or is the sequela of an acute attack, and is more likely to supervene in syphilitic individuals. The membranes become hyperæmic and thickened, and adhesions between the cord and its membranes may occur. The extensions of the pia mater into the cord readily explain the fact that a chronic sclerosing myelitis is frequently associated with this affection. The *Symptoms* are those of localized pain and rigidity in the back, increased on all movements, and accompanied by shooting pains and hyperæsthesia, and perhaps muscular pains and cramps. The reflexes are usually exaggerated and vesical complications may follow. *Treatment* consists in prolonged rest, with counter irritation in the form of blisters or the button cautery applied to the back, whilst mercury is administered internally.

**Spinal Myelitis**—Inflammation of the spinal cord may follow injuries of the spine, either as a direct consequence of depressed or displaced bone or from simple concussion or contusion with hæmorrhage. It may also be caused at a later date by extension of inflammation from the meninges, or result from compression by lymph, pus, granulation or cicatricial tissue, or callus. It may be acute or chronic. In the former the cord becomes red and softened, the nerve elements are destroyed and finally replaced by cicatricial tissue if the patient live long enough. In chronic cases the connective tissue becomes thickened and the nerve structures compressed and disintegrated, whilst the meninges are always adherent and thickened.

*Symptoms*—**Acute Myelitis** is evidenced by the presence of pain in the back and along the course of the nerves arising from the inflamed area, hyperæsthesia, and muscular cramps in the earlier stages soon followed by paralytic symptoms, if these are not already present as the result of the injury. The irritative symptoms

are, however, much less marked than in acute meningitis. The reflexes vary according to the amount of destruction of the cord substance, whilst muscular atrophy is not especially rapid, except in those muscles formerly supplied from the affected area. The sphincters of both bladder and rectum are paralyzed causing retention of urine and incontinence of feces; the former is almost invariably followed by septic cystitis, especially when the trophic centres in the lumbar enlargement are involved. Bedsores are very liable to be produced, and may become very extensive and serious. Priapism and hyperpyrexia are often present when the cervical region is affected. The fatal issue is usually due to septic poisoning from the urinary tract, or perhaps from the bedsores.

**Chronic Myelitis** gives rise to a great variety of symptoms but those most marked are a gradually increasing motor weakness, going on to paralysis, together with various sensory phenomena ending in anæsthesia, whilst there is trouble with the bladder and rectum.

The treatment of each of these conditions is mainly symptomatic.

**Spinal, or Traumatic, Neurasthenia (Syn. Railway Spine, Indirect Concussion of the Spine)**—Cases are not uncommonly met with in which although there has been no direct injury to the spinal column or cord and no immediate symptoms of importance, the fact is manifestly demonstrated in various ways that considerable commotion and disturbance have been produced in the nervous system. Railway accidents are the most common cause of this condition but it may arise from any jar to the spinal column. The reason why railway accidents are so often responsible for this state is that the forces employed are very great and the collision unexpected so that the muscles and ligaments are taken at a disadvantage being off their guard, whilst the shock, terror and mental disturbance are also important factors. Ligamentous and muscular lesions—i.e., sprains and strains—are the usual local phenomena produced by such accidents.

In the majority of cases the symptoms are mainly due to excessive irritability and weakness of the spinal and cerebral centres, constituting a condition of nerve prostration, or *Neurasthenia*, and the history will usually be somewhat of this type. The individual at the time of the accident is thrown from side to side or severely shaken but does not lose consciousness and although feeling somewhat dazed is able to alight without help and may even assist others. He perhaps continues his journey, and goes to his business, but finds in the course of a few hours that his back is painful, his head aching and that he cannot apply himself to his work. He returns home and goes to bed sending for his doctor, who will probably prescribe rest and bromides. His condition remains for a time unaltered; he complains of pain and tenderness over certain regions of the spine especially the lumbar, and is unable to walk or to undertake any serious mental or physical effort, whilst all excessive sensory stimuli such as a bright light or noise are unusually disturbing. Neuralgia is often present, whilst the pulse is weak, the urine may be retained or may dribble away, and the temperature be for a time subnormal. Accommodative asthenopia (or the inability to accommodate for near objects) resulting in a temporary condition of presbyopia, is also a marked feature in many of these cases. All the symptoms are aggravated by mental excitement and exertion such as are often produced by the necessary interviews with doctors and solicitors pending the financial compensation by the railway company. The immediate improvement which often follows the satisfactory settlement of his claim for damages is not necessarily due to imposture, but may result from the removal of mental tension and anxiety.

This condition of neurasthenia may develop immediately after the accident as an acute condition, the patient lying helpless and prostrate, or more often chronically as in the more common type of cases described above. To it, however, is frequently added a considerable element of *Hysteria*, in the form either of acute attacks of hysterics, or of a chronic unconscious exaggeration of the sensory symptoms. If the patient is examined in the supposed hyperæsthetic area whilst his attention is distracted, possibly no pain will be complained of.

The *Prognosis* is generally favourable, the patient recovering in time but in a few instances permanent effects may be produced.

In the *Treatment* a good deal of care is needed to judge rightly when the period has arrived for encouraging movement rather than rest and thus to prevent the

patient from developing a condition of chronic invalidism. Rest in bed is to be recommended at first, bromides given in moderation, and fomentations applied locally. Later on friction with liniments and massage should be employed and when all chance of secondary inflammatory disturbance is at an end, movement should be encouraged and change of air advised, whilst a course of strychnine and iron may be administered.

In a few cases, however fortunately much rarer, the symptoms run on into those of a chronic inflammatory condition of the spinal cord and its membranes and these, to which Erichsen formerly applied the term *Indirect Concussion*, are of the gravest import. In others, nothing may be noticed by the patient for some weeks or months beyond the fact that he feels a little shaken, and not so capable of doing his work as formerly, but, at the same time he loses flesh and looks worn and fagged. Gradually other phenomena develop. His brain-power is diminished, and any mental effort causes him to be muddled, memory fails, the temper is irritable and his sleep disturbed, the head is often hot. The vision is usually defective, and he complains of noises in the ears. The sense of touch is impaired, so that all delicate movements are hindered. The spine is kept rigidly stiff, the head fixed and the gait is somewhat unsteady and shambling. The walking powers are much diminished, and going up and down stairs is especially difficult. Motor power in all regions of the body is partly lost, any or every modification of sensation may be met with, whilst the reflexes are increased. The bladder may lose its power of retaining urine for a time, but this is not always a marked symptom. There is great impairment of both sexual desire and power. On examining the back, distinct tenderness is felt over one or more spots, especially in the lower cervical, mid-dorsal, and lumbar regions. In such cases, where the symptoms develop slowly, and remain unaltered by treatment the *Prognosis* is most unfavourable, since they are probably due to inflammatory changes in the cord and brain and although the patient may live for years, yet he is permanently crippled, and becomes a confirmed invalid. *Treatment* in the earlier stages consists of rest, preferably on a prone couch, with counter-irritation, such as blisters, or even the actual cautery over the spine, whilst mercury or iodide of potash, and bark are administered. Careful nursing, massage of the limbs, and galvanism, are needed, and warm sea-water douches may be most useful. If, however, no improvement follows, the patient must be encouraged to get about as best he can, and to go out in an invalid chair so as to maintain the general health whilst careful attention is directed to the personal hygiene.

### Paraplegia

Paraplegia arises in the course of spinal injuries from a variety of causes, which may be classified as follows

- 1 Paraplegia arising immediately after the accident, from
  - (a) Direct concussion without evident lesion, if such a condition be possible,
  - (b) Disintegration of the cord from intramedullary hæmorrhage, or from contusion without displacement of bone,
  - (c) Displacement of bones, with or without recoil, crushing the cord,
  - (d) Penetrating wounds dividing the cord

However produced, the same symptoms manifest themselves if the lesion is complete, recovery is alone possible in the first and perhaps in the second group, whilst in the other forms the paraplegia is maintained by a subsequent acute transverse myelitis.

- 2 Paraplegia arising after an interval, from
  - (a) Extramedullary spinal hæmorrhage, if the symptoms show themselves without pyrexia in twenty-four or forty-eight hours,

- (b) The pressure of inflammatory exudations, as in spinal meningitis, when the symptoms are preceded by inflammatory phenomena, and do not appear before seventy-two hours at the earliest,
- (c) The pressure of callus or of cicatricial adhesions around the cord and membranes (*ie*, peripachymeningitis)

It is unnecessary to discuss further the special signs and symptoms accompanying each form, they have been already mentioned. We merely propose to indicate briefly the effects of a total transverse lesion, and then to describe the results of paraplegia as they vary with the situation of the injury. It must be remembered that the nerves are derived from spinal segments which are always at a higher level than the exit of the nerves from the canal—*ie*, the nerves travel downwards within the spinal canal for a variable distance, less in the cervical region, more in the lumbar, before escaping through the intervertebral foramina.

**A Total Transverse Lesion**, destroying absolutely one segment of the cord, will result in the following symptoms

1 Paralysis of the muscular area supplied by the destroyed segment, followed by rapid atrophy, reaction of degeneration, and loss of reflexes in this particular group of muscles

2 Paralysis of all the muscles supplied by the segments below that which has been destroyed. The trophic condition remains normal, at any rate, for a time, but when secondary descending degeneration in the antero-lateral columns has occurred, the muscles become contracted, tense, and rigid (late rigidity). The condition of the reflexes after a total transverse lesion has been a fertile source of discussion, but it is now maintained that the deep reflexes are entirely and permanently lost, whilst the superficial reflexes, though absent for a time, may reappear. It, however, a portion of the cord remains intact, both superficial and deep reflexes may persist or reappear, and even be exaggerated.

3 Complete anæsthesia of the sensitive area supplied by the destroyed segment, and of all the sensitive areas below, and loss of the muscular and thermal senses

4 A narrow zone of hyperæsthesia is found at the upper level of the anæsthetic area, due to the irritation of the nerve roots at the site of injury

5 Vasomotor paralysis combined with trophic disturbances in the parts which are paralyzed

6 Visceral changes, especially in the bladder and rectum

**Phenomena of Paraplegia at Different Levels** 1 **At the Upper End of the Sacrum**—Total transverse lesions at this spot are exceedingly rare, they only involve the cauda equina and cause paralysis of the sacral plexus. The effects produced are (1) Paralysis of all the muscles of the legs, except those supplied by the anterior crural nerve, the obturator, and the superior gluteal, whilst the perineal and penile muscles are also affected. (11) Anæsthesia of the penis, scrotum, perineum, lower half of the gluteal region,



and the whole of the legs, except the front and outer parts of the thigh, which are supplied by the cutaneous branches of the anterior crural, and the region supplied by the long saphena (iii) The bladder and rectum are both shut off from their spinal centres, and hence there will be temporary retention of urine, followed by distension with overflow, and incontinence of fæces. The bladder, however, gradually contracts, its walls become thickened, and its capacity steadily diminishes, so that incontinence becomes more and more absolute.

2 If the lesion is situated in the **Dorsi-lumbar** region, or passes through the lumbar enlargement, which corresponds to the twelfth dorsal and first lumbar vertebræ, there is complete paralysis of the muscles of both limbs, including those passing to them from the trunk, total anæsthesia of the legs, gluteal and perineal regions, and possibly the lower part of the abdomen, whilst, if the vesical centres are destroyed, there is total paralysis of the bladder, with relaxation of the sphincter, dribbling of urine, which early becomes ammoniacal, and cystitis, due to trophic changes, if the centres escape, retention with overflow is the usual result. The rectum and sphincter ani are paralyzed, causing incontinence of fæces, the passage of which is unrecognised from the anæsthetic condition of the anus.

3 In the **Mid-dorsal** region the same phenomena are met with, but to them are added a more extensive region of anæsthesia, limited above by a hyperæsthetic zone, which feels like a tight painful girdle round the waist, paralysis of the flat abdominal muscles, retention of urine, followed by distension with overflow, which, however, when asepsis is maintained, may occasionally be followed by a state of reflex micturition in which the patient passes water unconsciously and involuntarily, whenever there is sufficient present to cause sensory stimuli to ascend to the undamaged centres. The abdominal paralysis is a most important addition to the gravity of the case, for all straining movements are thereby prevented, and thus coughing is embarrassed and defæcation hindered. The gases developing from the stagnant fæces accumulate and cause distension of the belly (meteorism), and thereby respiration may be seriously impaired. The diaphragm, moreover, is hampered in its action, since the lower ribs cannot be fixed or steadied, and hence its contractions tend to pull them inwards, instead of increasing the dimensions of the thoracic cavity.

4 In the **Cervico-dorsal** region all these phenomena are present, but the anæsthesia extends over nearly the whole trunk, and the hyperæsthesia may involve the arms, whilst the intercostal and spinal muscles are also paralyzed. Respiration has therefore to be carried on by the hampered diaphragm, with the assistance of a few of the accessory respiratory muscles in the neck, and hence is much impeded, if bronchitis is present, it will prove fatal by asphyxia in a few days from the inability to expectorate. Priapism is a marked feature of cervical paraplegia.

5 In the **Lower Cervical** region the arms also become involved in both the paralysis and anæsthesia, and if the lesion is situated at or above the fourth cervical vertebra, instant death results from paralysis of the phrenics and consequent stoppage of the respiration.

**Death from Paraplegia**, therefore, may arise from a variety of causes and at various periods. It may be immediate, from respiratory failure in lesions above the fourth cervical vertebra, or it may occur from accumulation of mucus or pus in the air-passages, when the lesion is in the upper dorsal region, or it may be delayed for weeks, or even months, and then is due to sloughing of the nates, or septic absorption from an inflamed or ulcerated bladder, which is often associated with suppurative pyelonephritis.

The **Prognosis** and **Treatment** both depend on the position and character of the lesion causing the paraplegia, and on the previous habits and condition of health of the individual.

### Laminectomy

By laminectomy is meant an operation for the removal of the laminae and spinous processes of one or more vertebrae, in order to relieve pressure on the cord, whether due to depressed bone, abscess, granulation tissue, excessive callus, cicatrices, or tumours. The operation consists in making a longitudinal incision in the middle line of the back, extending to the spinous processes, the muscular and tendinous structures are then cleared from the posterior aspect of the vertebrae as far as the transverse processes, a proceeding usually attended with considerable hæmorrhage, which can be checked, perhaps, better by hot sponge pressure than by attempting to secure the individual vessels. The neural arches are then examined for injury, etc., and those which seem to be most affected removed by cutting pliers, Hey's saw, or laminectomy forceps. The posterior aspect of the membranes of the spinal cord is thus exposed, and the various conditions which may be present are dealt with according to circumstances. In this place we have merely to consider the use of this operation after injury to the spine. For its employment in other conditions see Chapter XXIV.

It must be remembered as a fundamental principle that repair is impossible after the spinal cord has been divided, or any one segment totally disintegrated, and hence, if it is certain that a total transverse lesion of the cord has been caused by an accident, it is absolutely useless to operate. Early and complete disappearance of all the reflexes is a suggestive phenomenon, but cannot be looked on as absolute evidence of a total transverse lesion, if, however, in addition to complete sensory and motor paralysis, the deep reflexes remain absent for any length of time, even though some of the superficial ones have reappeared, operation is useless. The presence of the deep reflexes is always an evidence that at any rate a portion of the cord remains uninjured, and would encourage one to operate. This question cannot, however, be absolutely settled in the early stages of the case, as it is at first impossible to say whether the symptoms are due to concussion, hæmorrhage, or bony pressure. Fortunately, delay does not appear to be so prejudicial to the patient's welfare as one might at first expect, and many cases are on record in which a good result

was obtained even after months. One is therefore justified in waiting a while in doubtful cases. In spite of this, however, there will always be a certain number of cases in which it will be a matter of doubt as to whether or not any benefit will accrue from operation. The final decision under such circumstances will depend on the special predilections and opinions of the surgeon who is in charge of the case, and the general state of the patient.

Apart from these doubtful cases, the following are generally admitted as being suitable for operation: (1) Pénetrating wounds or fractures with displacement which involve the spine below the first lumbar vertebra, the cauda equina is present below that level, and not the spinal cord, and it is reasonable to treat it in the same way as one would treat a single peripheral nerve, (2) when the injury is mainly limited to the neural arch, which has been driven in by direct violence, (3) in all cases of bilateral dislocation of the cervical spine where the patient is not moribund, (4) if paraplegia arises with or without inflammatory symptoms, when an interval has elapsed since the accident, the pressure in such cases may be produced by blood or inflammatory exudations, and benefit may possibly arise from the operation, if, however, it is due to a total transverse myelitis, no good can follow. (5) When symptoms of irritation or paralysis supervene at a later date, from contraction of cicatrices around the cord or its membranes (peri-pachymeningitis), or from excessive callus formation, laminectomy may be performed with good hopes of a successful result.

## CHAPTER XXIV

### DISEASES OF THE SPINE

#### Spina Bifida

By **Spina Bifida** is meant a condition of imperfect development of some portion of the posterior aspect of the spine, with or without a similar affection of the spinal cord and membranes

It must be remembered that the spinal cord is developed as a linear involution of the epiblast, the edges of this medullary groove growing up and uniting, so as to include a passage lined with epithelium, and subsequently known as the central canal. The cord is gradually separated from the overlying skin by an intrusion of mesoblastic elements, from which the vertebræ, together with the spinal muscles and ligaments, are developed. The ossification of each vertebra originates in three main centres—one for the body, and one for each half of the neural arch, whilst epiphyses are developed as plates above and below the body, as also for the transverse and spinous processes.

The following are the chief forms of spina bifida

1 A **Myelocoele** results from non-closure of the primitive medullary groove. It is characterized by the appearance in the lumbo-sacral region of a raw surface, which consists of the spread-out structures of the spinal cord, at the upper part of which opens the central canal. The condition is evidently incompatible with life, and the children, if they are not stillborn, as is usually the case, do not live beyond a day or two.

2 A **Syringo-myelocoele** (Fig 260) arises from a distension of the central canal of the cord, the posterior portion of which usually remains adherent to the skin, from which it has never been separated, owing to defective development of the mesoblastic tissues. The spinal nerves travel round the walls of the cyst in order to find their way to the intervertebral foramina. Trophic phenomena are nearly always a prominent feature of these cases.

3 A **Meningo-myelocoele** (Fig 261) is due to a development of fluid within the membranes which remain adherent to the skin, the spinal cord or nerves of the cauda equina passing down the posterior aspect of the cavity as a strap, and the nerves traversing and perforating the sac to reach the intervertebral foramina.

4 A **Meningocele** (Fig 262) is characterized by a protrusion of the membranes, containing cerebro-spinal fluid, through a defect in the posterior walls of the vertebræ, the spinal cord and nerves being in their normal position. This variety is uncommon.

Of these forms, the meningo-myelocele is that most frequently seen in living children, although, according to Bland Sutton, from whose book on Tumours the above description is mainly derived, the first is really the most common.

**Clinical Characters**—A spina bifida is recognised by the appearance of a tumour in the middle line of the back (Fig 263), most commonly involving the lower part of the spine, it may be covered by normal skin, but usually that over the convexity is thin and translucent, and not unfrequently a number of small dilated vessels are seen coursing over it. On compressing the tumour, its size can

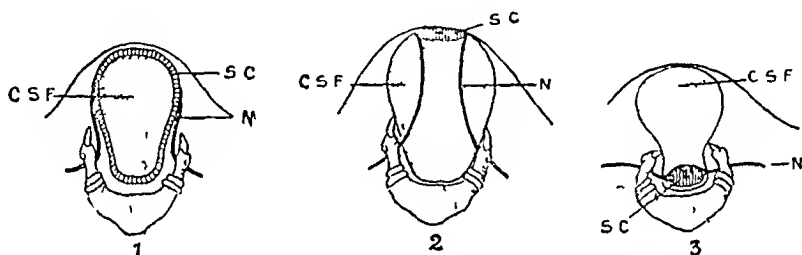


FIG 260—DIAGRAM OF  
SYRINGO-MYELOCELE

FIG 261—DIAGRAM OF  
MENINGO-MYELOCELE

FIG 262—DIAGRAM  
OF MENINGOCELE

S C, Spinal cord C S F cerebro spinal fluid in sac, N nerves

be diminished, and in infants distension of the anterior fontanelle can be felt, showing that the sac is filled with cerebro-spinal fluid, and there is always a distinct impulse on coughing or crying. The defect in the posterior portion of the vertebræ is very evident, the edges of the bones being felt at the margins of the tumour. Various other deformities may be associated with spina bifida, especially hydrocephalus and talipes, which are perhaps most common in cases of syringo-myelocele, whilst perforating ulcer, ankylosis of the terminal phalanges of the toes, and other trophic phenomena, are also developed, perhaps at a much later date.

The **Prognosis** of the case depends mainly on the thickness and character of the overlying skin. If it is thin, and the cord evidently adherent to it, as sometimes indicated by a cicatricial depression or dimple, the sac is very likely to give way, causing either death from sudden escape of cerebro-spinal fluid, or a fatal issue in a few days from septic meningitis. If the spina bifida is small, and covered with healthy skin and subcutaneous tissue, the patient may reach adult life, but even then trophic phenomena may supervene, possibly as the result of the presence and development of foci of cavernous tissue, which have been shown to occur in the canal when the cord is absent. Occasionally a meningocele, with only a small aperture

of communication with the spinal canal, is cured spontaneously by the gradual development of the bones constricting the neck of the sac

**Treatment**—The majority of these cases are best left alone, the tumour being merely guarded from injury by the application of a suitable cap. If the sac is gradually increasing in size, and threatening to give way, operative interference is absolutely necessary if life is to be saved. Acupuncture through the thinned integument, the cerebro-spinal fluid being allowed to drain away subsequently into an antiseptic dressing, or tapping through the healthier integument around the base, repeated several times, and followed by compression, may lead to a cure in favourable cases. Statistics, however, go to prove that the best results are obtained by tapping, followed by the injection of Morton's fluid (R. iodi, grs.  $\times$ , pot. iod., grs.  $\times \times \times$ , glycerinum, ad  $\bar{z}$ i). A small quantity of the cerebro spinal fluid is withdrawn, and then from half a drachm to a drachm of the iodine solution is introduced. It diffuses itself slowly, and its action is localized, so that if the child is kept quiet, and only semi-recumbent, its effect will be limited to the sac of the spina bifida and its neighbourhood. In some cases persistent leakage may follow this treatment, and such is dealt with by means of a firm antiseptic compress, in many the injection needs to be repeated more than once.

Of late years treatment by an open operation has been coming more and more into vogue. Naturally, it is chiefly applicable in the meningocele type, and infants or those suffering from trophic phenomena do not stand it well. An incision is made over the sac, either in the middle line if it is certain that the cord is not there, or to one side, if it is. The child should be kept with the head low when the sac is opened, so as to limit, as far as possible, the loss of cerebro spinal fluid. In a meningocele, the protruding membranes are cut away, the wound in them is very carefully sutured, and the spinal muscles drawn together by deep stitches, so as to create an extra protective barrier, in addition to the skin and subcutaneous tissues. When the cord runs down the back of the sac, it is freed by incisions on either side, and if it cannot be separated from the skin, the whole strip is



FIG. 263.—SPINA BIFIDA IN A LAD AGED SIXTEEN PROBABLY OF THE MENINGO MYELOCELE TYPE (FROM A PHOTOGRAPH)

The swelling had not increased much in size since he was a child but distinct trophic phenomena were being developed in the shape of talipes of both feet

replaced in the vertebral canal, the membranes are closed over it, and finally the muscles and skin are united by rows of sutures. The results obtained by this means have been encouraging, and in suitable cases operation may be recommended with some prospect of success.

**Spina Bifida Occulta** is the term applied to a condition in which the posterior portion of the vertebræ is absent, but without any protrusion of the cord or its membranes. The overlying skin may be cicatricial in character, or a large growth of hair may arise from it, occasionally a lipoma develops in this situation, and by its downward growth compresses the spinal cord, causing paraplegia. Unless such a condition is present, spina bifida occulta calls for no treatment, but an exploratory operation should always be undertaken when nervous phenomena supervene.

### Congenital Sacral Tumours

Other congenital conditions of the lower end of the spine are described as congenital sacral or coccygeal tumours. The majority of these arise from what is known to embryologists as the *neurenteric canal*. In early foetal life it is supposed that the neural and alimentary canals are continuous, the passage of communication being known by the above name. Ordinarily, it entirely disappears after the union of the proctodeum with the intestine, but evidences of its existence are occasionally met with, either in the form of a cicatricial dimple adherent to the tip of the coccyx (*post-anal dimple*), or as one of the following conditions.

(i) A *dermoid cyst*, containing the usual mixture of sebaceous material and epithelial cells, and often a tuft of hair, it develops in the space between the rectum and coccyx, and may either project posteriorly, below the coccyx, or open into the rectum, the tuft of hair may thus find its way out of the anus. In a case under the care of Mr W. Turner, at Westminster Hospital, it was actually connected with the spinal meninges, removal involving the loss of cerebro-spinal fluid.

(ii) A tumour of a glandular or adenomatous nature is occasionally found in the same region. It is characterized microscopically by the existence of alveoli, lined by cuboidal epithelium, held together by connective tissue, it may attain a large size, but is quite innocent. Such growths are termed by Bland Sutton *thyroid-dermoids*, but a better name would be a *congenital adenoma* of the post-anal gut.

Various other tumours are met with in infants in this region, and the same title of congenital sacral or coccygeal tumour has sometimes been applied to them.

(a) A *spina bifida* of the meningocele type, which may communicate with the subdural space, or may have been shut off by a natural process of cure.

(b) A *lipoma* may also form here, and in some cases has simulated by its shape a caudal appendage.

(c) A partially developed foetus may be met with, enclosed within the subcutaneous tissues of the sacral region, and known as a *teratoma* (p. 215).

(d) *Sarcoma* and *cystic hygroma* have also been observed

The conditions are so exceedingly rare that it is unnecessary to enter into details of treatment, which is conducted in accordance with general principles

### Inflammatory Affections of the Spine

**I Acute Osteo-myelitis of the Spine** is uncommon. It is due to the same causes as similar disease elsewhere, viz, infection with pyogenic organisms in an individual of low germicidal power. It is characterized by severe pain in a localized portion of the back, and fever, deformity is not a marked feature, since massive necrosis occurs and not a gradually destructive caries. Abscesses form early, and there is great danger of an extension of the inflammation to the spinal meninges, leading to a fatal issue. The prognosis is extremely bad, owing to this latter complication, and the only possible treatment consists in early incisions to give exit to the pus. Sequestra can easily be removed from the back of vertebræ, but from the front only in the lumbar and cervical regions.

**II Tuberculous Disease of the Spine or Spinal Caries** (*Syn* Pott's Disease, Angular Curvature) — The above names are applied to a condition due to tuberculous disease of the vertebræ, originating almost invariably in their bodies, which are more or less destroyed, leading to the so-called 'angular curvature'. The term 'Pott's disease' is derived from Percival Pott, who first described it accurately in 1779.

**Ætiology** — The causes of tuberculous disease of the spine are much the same as those of tuberculous affections elsewhere, viz it affects an individual predisposed to the development of tuberculous disease either by inherited tendency, or by impairment of the general health, as from some preceding illness, or exposure to defective sanitary conditions. The actual deposit of tubercle is probably determined by some injury, such as a strain or sprain of the vertebral column, or of the soft parts attached thereto, which, though slight and perhaps not noticed at the time, is sufficient to cause local diminution of vitality, thereby constituting a favourable nidus in which the *B. tuberculosis* can develop. It is most frequently met with in children, but may arise at any age, and equally in either sex. Any part of the spinal column may be involved, but the lower dorsal is by far the commonest. The cervical region is rarely attacked, except in children, whilst in adults the dorsi-lumbar vertebræ are the favourite seat.

**Pathological History** — The actual changes in the bones in Pott's disease are exactly similar in nature to those we have already described as occurring generally in cancellous bone (p 585). The disease starts in one of two places, either under the periosteum covering the anterior surface of the vertebræ (this most often in adults), or at the line of junction of the upper or lower plate-like epiphyses with the body, the usual situation in children. In the former case the subperiosteal tuberculous deposit early extends to



the subjacent bone, and spreads to neighbouring vertebræ, either along the under surface of the anterior common ligament, or through the intervertebral discs, which are disintegrated by the process. When it spreads along the anterior common ligament (Fig 264), the disease may be very extensive, body after body being eroded, and the intervertebral discs suffering even more than the bones. In

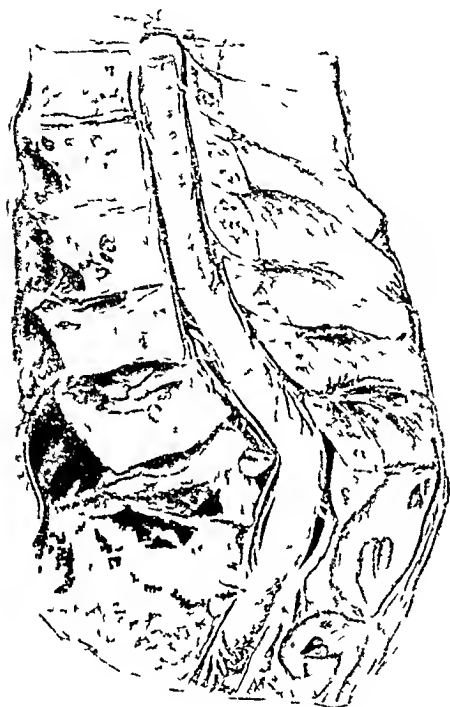


FIG 264 — TUBERCULOUS DISEASE OF SPINE, SHOWING DESTRUCTION OF THE BODIES OF THE VERTEBRÆ, AND ABSCESS FORMATION BENEATH THE ANTERIOR COMMON LIGAMENT (MODIFIED FROM SPECIMEN IN COLLEGE OF SURGEONS MUSEUM)

such a case the deformity produced is not angular, but rather of a general kyphotic nature. Occasionally, however, the disease starts simultaneously in many foci, so that the bodies of several vertebræ become pitted and carious, without producing general destruction. In other cases the process is limited to the bodies and intervertebral discs of two adjacent vertebræ, the periosteum being but little affected. This variety is, perhaps, most common in the lumbar region, where the bodies of the vertebræ are large and permit a limiting zone of sclerosed tissue to form, it is also not uncommon in this situation in adults to find definite sequestra (Fig 265).

Cure is effected by the bodies of the vertebræ falling together and becoming ankylosed, so that a deformed and immobile condition of the affected portion of the spine is often the best result that can be anticipated. The new bone thus formed becomes in time sclerosed and

very dense, and the synostosis also involves the spines and laminæ. In favourable cases this occurs without suppuration, but not unfrequently abscesses form and add much to the gravity of the condition. Occasionally, the tuberculous process extends backwards through the body of the bone so as to implicate the posterior common ligament, and paralytic or other symptoms may then arise from pressure on the cord.

Rare cases have been described in which the disease mainly affected the sides of the vertebræ, as a result of which lateral deformity occurred, and still more uncommon are those in which the posterior portion of the neural arches is primarily involved.

In the upper cervical region the disease usually starts in the large joints, either between the occiput and atlas, or between the atlas and axis. For a time it may be limited to one side, but usually the bone is attacked at an early stage, and the trouble then spreads to other joints. A special complication of this variety will be mentioned hereafter (p 731).

**The Signs and Symptoms** produced by tuberculous caries of the vertebrae vary considerably in different situations, but for practical purposes may be described under the following five headings

1. **Pain** is a constant and invariable accompaniment of the disease, although in the early stages it may not be specially prominent, being only elicited by careful examination. It is of two main types, the local and the referred. *Local pain* is more or less similar in character to that always experienced in disease of bones, although, owing to the cancellous nature of the osseous tissue involved, there is often but little tension, and hence it may be slight. It can, however, be elicited in all cases, either by pressure or percussion over the spines, or perhaps more effectively by pressing upon the transverse processes, so as to induce rotation of the vertebral bodies one on another or twisting, are similarly painful, whilst the same result can be brought about by jarring the spine, as by a blow on the head or nates. The old plan of testing for pain by means of a hot sponge applied over the back is comparatively useless in this disease. *Referred pain* is produced by pressure upon, or irritation of, the roots of the nerves as they emerge from the intervertebral foramina, consequently it is always noticed in those parts of the body which are supplied with sensation by the nerves issuing from the spinal canal in the diseased area. If the lumbar region is affected the pain is referred down the legs, in the dorsi-lumbar region it may follow the last dorsal nerve, and be noticed in the lower part of the abdomen, or in the gluteal region, in the lower dorsal region pain is referred to the epigastrium, children who are unable to differentiate its precise nature complaining of 'belly-ache', in the upper dorsal and lower cervical regions the pain extends into the arms, whilst in the upper cervical region neuralgia follows the course of the cutaneous branches of the cervical nerves. Thus, if the third and fourth cervical

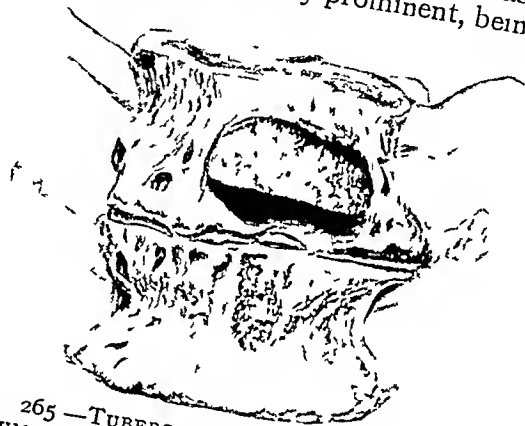


FIG 265.—TUBERCULOUS DISEASE OF TWO LUMBAR VERTEBRÆ SHOWING SEQUESTRUM ON THE ANTERIOR ASPECT AND LATERAL THICKENING PREVENTING ANGULAR DEFORMITY (COLLEGE OF SURGEONS MUSEUM)

nerves are involved, pain is felt along the course of the descending sternal, clavicular and acromial branches, if the second and third are implicated, pain may be confined to the great auricular and occipital nerves, if the atlas and axis are affected, the neuralgic pain, if any, follows the occipital branches

2 Rigidity of the spine is a constant accompaniment of Pott's disease. In the *early* stages it results from muscular spasm, the object being to fix and immobilize the painful part. If the lower portion of the spine is involved, the back is held stiff and straight, the patient abstaining from all movements which would bend or stretch it. Thus, in order to pick up an object from the floor, the knees and hips are flexed, and the patient gradually lets himself down with an absolutely rigid back into a sitting or squatting posture, the

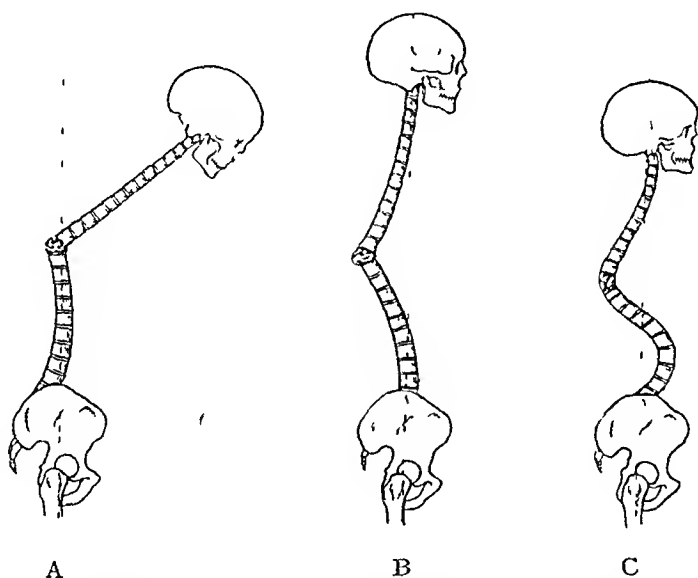


FIG 266 —DIAGRAMS TO ILLUSTRATE DEFORMITIES IN SPINAL CURVATURE  
(AFTER NOBLE SMITH)

In A the result of the bodies falling together to form a wedge shaped mass is seen in the anterior displacement of the upper half of the spine in B the compensatory curves utilized by Nature to maintain the erect posture are indicated in C the same process is seen in an exaggerated degree

body is raised in a similar manner by resting the hands upon the thighs, the patient, as it were, climbing with extended arms up his own legs. In a child rigidity in the dorsi-lumbar region can be demonstrated by laying him on his face, grasping the ankles, and ascertaining the amount of movement of the spine at that region by lifting the legs from the table, and also by moving them from side to side. In a healthy child the legs can be elevated, and the spine bent back in the dorsi-lumbar region, nearly to an angle of sixty degrees, whilst lateral mobility to the extent of thirty or forty degrees on either side of the median line is obtainable. When caries is present,

neither of these movements can be made without including the thorax and dorsal spine. In cervical caries the patient steadies the head, and at the same time raises the shoulders by the help of the trapezius and sterno-mastoid muscles, whilst the chin is often supported by one hand, and the patient twists his whole body in order to look sideways.

In the *later* stages, when repair is taking place, or has occurred, rigidity of the spine is due to osseous ankylosis. After a cure has been established, compensatory movements of other portions of the spine mask, to a certain degree, the localized rigidity.

3 **Deformity**, the result of Nature's method of repair by means of osseous ankylosis, is necessarily present in almost all instances, although in a few cases, taken in hand early, it is possible that recovery may occur without it. The amount and character of the deformity depend on a variety of circumstances, and perhaps most of all upon the number of vertebræ affected. Where only two bones are involved, a true angular deformity may result, the body of the upper vertebra being welded to that of the lower, so as to produce a wedge-like mass (Fig 266, A), the surfaces of which are inclined to one another at an angle, compensatory curves of the spine elsewhere enable the patient to assume the erect posture (Fig. 266, B). In the lumbar region (and to a less extent in the cervical) loss of the normal forward convexity is often the most marked feature, the vertebræ being piled, as it were, one above the other, so as to constitute an absolutely vertical column (Fig 268). When the affection is limited to two lumbar vertebræ, there is usually little or no displacement, the disease occupying the centres of the bones, so that the sides may escape altogether, and preserve the integrity of the spinal column, if a distinct projection of the spine is present, the portion of bone which appears most prominent is the spinous process of the lower of the vertebræ. Owing to the obliquity and length of the spinous processes of the dorsal vertebræ, the projection, even when only two bones are involved, is very considerable, in the latter case the spinous process of the upper vertebra, by becoming horizontal, is the more prominent. When a large number of dorsal vertebræ are affected, the curvature is never angular, but the whole region becomes bent forwards, and kyphotic in type, or even almost rectangular (Fig 267). In the cervical region there is rarely much deformity, owing to the small size of the vertebræ, and to the stunted shape and deep position of the spinous processes, if, however, several bones are involved, the head may be carried forwards, together with the upper part of the spine.



FIG 267 — WELL MARKED ANGULAR CURVATURE AS A RESULT OF POTT'S DISEASE

Secondary changes in the shape of the thorax necessarily accompany the more advanced cases of caries in the dorsal region, the sternum becoming convex anteriorly so as to compensate for the diminished vertical measurement of the thorax, and the ribs crowded together to such an extent as to almost obliterate the intercostal spaces. The lower floating ribs may, however, retain their normal position, and thus a horizontal groove may be produced corresponding to the line of the tenth rib. In such cases the patient becomes much stunted in growth and dwarfed, constituting the typical 'hunchback.'

4 Abscess is the most serious result of spinal disease, for, owing to its deep origin, it often attains considerable dimensions before it is recognised or treated, whilst it is usually impossible to deal with the causative lesion in the bones, and if once the cavity is allowed to become septic, an exceedingly grave complication is introduced into the case, which may even determine a fatal issue. The pus collects originally on the anterior aspect of the vertebræ, beneath the anterior common ligament (Fig 264), which may be stripped from the bones for a considerable distance, owing to the tension within the abscess cavity. It thence finds its way to the sides of the bodies after perforating the ligament, and burrows in various directions, according to the portion of the spine involved.

In the cervical region a *chronic retropharyngeal abscess* is first formed, it pushes the posterior pharyngeal wall forwards, and may be detected from the mouth as an elastic fluctuating swelling, which, by its size, often leads to some difficulty in swallowing and breathing, whilst œdema of the glottis may be induced. Left to itself, various courses are open to it. 1 The abscess may burst and discharge into the pharynx, the cavity necessarily becoming septic, and the osseous lesion thus aggravated. 2 It may travel downwards behind the œsophagus into the posterior mediastinum, and thence extend in the same direction as abscesses in the dorsal region. 3 More often the pus finds its way to the side of the neck, being guided to the posterior triangle by the prevertebral fascia, behind which it is situated, less frequently it pierces this fascia, and presents in the anterior triangle. 4 In the lower part of the neck, it may spread under the clavicle into the axilla, being directed by the same fascia, which in this region passes downwards behind the subclavian trunks, and forms the posterior wall of the sheath of the axillary vessels.

In the dorsal region, the abscess starts in the same way in front of the vertebræ, and may thence extend as follows. 1 Most frequently it passes backwards between the vertebral ends of the ribs to form a *dorsal abscess*, burrowing along the course of the posterior branches of the intercostal nerves and arteries, and forming a fluctuating swelling, 3 or 4 inches from the spinous processes, with an impulse on coughing. 2 It may extend between the ribs and the parietal pleura along the anterior branches of the intercostal vessels, coming to the surface at the spot where the lateral cutaneous branches are given off. Tuberculous disease of the ribs, leading to caries or necrosis, or even a localized empyema, may be induced in such cases.

3 Very rarely the abscess may travel up to the neck, pointing behind the sterno-mastoid muscle 4 Not uncommonly, however, it works its way downwards, passing under the ligamentum arcuatum internum of the diaphragm, thus entering the psoas sheath, and giving rise to a psoas abscess

In disease of the dorsi-lumbar or lumbar regions, either a lumbar or a psoas abscess may result A *lumbar abscess* (Fig 268) is due to the passage backwards of the pus along the posterior branches of the lumbar vessels and nerves to the outer border of the erector spinæ, and usually presents superficially in Petit's triangle—*ie*, between the adjacent borders of the latissimus dorsi and external oblique muscles It there forms a tense fluctuating swelling, with an impulse on coughing A *psoas abscess* lies within the sheath of the psoas muscle, the pus being usually superficial to the muscular fibres, some of which are probably destroyed It passes downwards, giving rise to a fusiform enlargement, deeply placed in the back of the abdomen, at the brim of the pelvis, it usually burrows outwards under the fascia iliaca to form a tense rounded swelling in the iliac fossa It thence travels under Poupart's ligament, behind and external to the common femoral vessels, being constricted at this spot so as to form a narrow neck

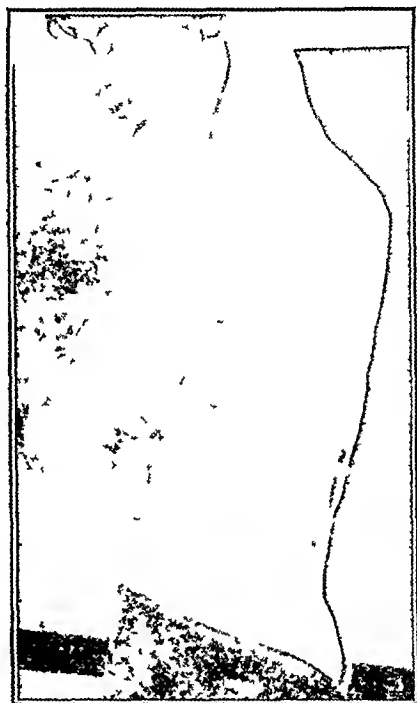


FIG 268 —LUMBAR ABSCESS, RESULTING FROM TUBERCULOUS DISEASE OF THE DORSI-LUMBAR VERTEBRÆ (FROM A PHOTOGRAPH)

The sac then expands behind the common femoral sheath, the vessels being often displaced forwards, and the vein flattened out and compressed Thence passing along the tendon of the ilio psoas, to the neighbourhood of the lesser trochanter, the abscess comes into relation with the internal circumflex artery, and usually points at or near to the saphenous opening to the *inner* side of the main vessels It may, however, follow the different branches of the internal circumflex amongst the adductor muscles, forming a large swelling on the inner side of the thigh, displacing these structures, or it may even travel along its main trunk behind the neck of the femur to reach the surface behind the great trochanter In other rare cases the abscess has been known to extend down the leg, and has even been evacuated by the side of the tendo Achillis Occasionally, the pus finds its way down into the pelvis instead of passing under Poupart's

ligament, and then points in the ischio-rectal fossa, or possibly burrows through the sacro-sciatic foramen

The constitutional disturbance associated with the formation of these abscesses is usually but slight, perhaps there is a small rise of temperature, but if, as occasionally happens, ordinary pyogenic organisms find their way into the sac from within the body, this may become more marked. As they come to the surface, considerable pain may be experienced from the tension and irritation of the soft parts, and fever of a hectic type is induced

5 **Paraplegia** is fortunately not a common result in tuberculous caries of the spine, only occurring in the worst or in neglected cases. It is scarcely ever due to the acuteness of the curve. It has been known to result from a fracture of the spine, the integrity of which has been weakened by the inflammatory process, but is usually caused by an extension backwards of the disease, so that a nodule or button of tuberculous material forms beneath the posterior common ligament, or pushes through it, compressing the cord against the laminæ, and actually invading the dura mater. It occasionally originates in the pressure induced by an abscess, which extends backwards into the spinal canal

The effect produced on the cord varies with the rapidity and acuteness of the process. When the pressure is rapidly developed, a subacute myelitis ensues, but more frequently it is of a chronic or sclerosing type. The cord is then found to be constricted or indented by the tuberculous mass, and perhaps considerably reduced in size, its texture is firmer than normal, and the colour grayish. The onset of symptoms may be suddenly induced by hæmorrhage or displacement of bone, but is more usually gradual. The dorsal region (about the eighth vertebra) is that most often involved, since there is plenty of space in the cervical region, and in the lumbar the cord has broken up into the cauda equina. Statistics seem to indicate that paraplegic phenomena occur in about one out of every thirteen cases.

The symptoms arising from pressure on the cord must be distinguished from those due to irritation of, or pressure on, the nerve roots. The latter causes neuralgic pain along the course of some particular nerve, possibly in the later stages associated with anæsthesia (*anæsthesia dolorosa*), or a limited motor weakness if the anterior roots are involved. In compression of the cord, motor phenomena are more evident than sensory, since the sensory track lies towards the centre of the cord, and so is more protected from injury. At first there is some dragging of the toes on walking, and loss of power in the legs, combined usually with neuralgia, weakness of the sphincters, and exaggeration of the reflexes. Later on the paralysis becomes complete, and, as degeneration of the cord follows, secondary contractions and rigidity occur, and the reflexes diminish. Absolute incontinence sometimes supervenes, the bladder emptying itself periodically and involuntarily, or the urine trickling away continually from either a full or empty viscus.

Special mention must be made here of a grave complication only

occurring in the upper cervical region, which may result in sudden death. Tuberculous disease of the upper two vertebræ usually originates in one or more of the large articulations on either side of the atlas, if these joints become disorganized, displacement may occur at any moment, and in this way the occiput slips forwards upon the atlas, and may lead to gradual or sudden compression of the cord and consequent death. The disease sometimes spreads to the body of the axis, and by this means the odontoid process becomes detached, or the transverse ligament gives way, in either case, the weight of the head carries the arch of the atlas forwards, and death ensues at once from compression of the medulla.

**Course of the Case and Prognosis** — Left to itself, the disease usually progresses more or less steadily, the bone lesion becoming gradually more marked, and abscesses are likely to develop. If treated efficiently, and taken in hand early, repair by ankylosis may be confidently expected. Even when an abscess forms, prolonged rest may lead to its disappearance, the fluid part of the pus being absorbed, and the solid elements becoming inspissated and dry, forming a putty-like mass lying on the front of the vertebral column, this may subsequently break down, probably owing to infection with pyogenic cocci, constituting what is known as a *residual abscess*. Should, however, the abscess burst or be opened, and become septic, symptoms of hectic fever and amyloid disease are almost certain to develop, and the patient is sooner or later exhausted by the discharge, and dies from asthenia. If dealt with judiciously, and sepsis avoided, the abscesses may be cured, and if at the same time the spine is kept at rest, and suitable hygienic measures are adopted, the lesion in the bones is able to consolidate. The onset of paraplegia, again, must not be looked on as rendering the case hopeless, since with prolonged rest the paralytic phenomena often disappear entirely. Septic cystitis and bedsores may arise as complications, and, if allowed to progress, cause the death of the patient. Occasionally, as a result of the implication of the spinal canal, diffuse meningitis follows, leading to a rapidly fatal termination. As in tuberculous disease elsewhere, the patient also runs the risk of acute miliary tuberculosis, whilst other organs, *e.g.*, the lungs, brain, or kidney, may become affected. In spite of these possibilities, however, the prognosis is good as regards life in cases free from complications, and where suitable treatment is practicable.

The **Diagnosis** of spinal caries is never a matter of difficulty when the characteristic deformity exists, but in the early stages, when the displacement is not evident, or if there is only a very slight prominence of the spinous processes, it is likely to be mistaken for a simple rachitic or statical curve, whilst if neuralgic pain is a prominent symptom, it may possibly be looked on as a case of spinal or intercostal neuralgia, or as rheumatism, or even be ascribed to renal affections. Tumours of the spine, such as cancer, or hydatid cysts, syphilitic disease, and aneurismal erosion, also produce symptoms somewhat resembling those of spinal caries, and in adults it may be



impossible to determine from the local phenomena alone which of these conditions is present, although a careful consideration of the general history and of the onset of the symptoms may throw some light upon the case. Frequently the course of the disease and the reaction to treatment must be mainly relied on in forming a diagnosis. The spine should always be examined from before and from behind, and pain on pressure over the transverse processes and rigidity of the back are the symptoms on which most stress should be laid.

The diagnosis of the abscesses connected with spinal caries is sometimes not devoid of difficulty, especially when they point in the *groin* or the *lumbar region*, since similar collections of pus may arise from a variety of other causes. (a) A *perinephritic abscess* is recognised by the association or pre-existence of symptoms of renal disease, whilst a spinal lesion may be absent. Of course, both conditions may be present in the same individual, and the diagnosis can then only be made by an exploration of the abscess cavity. (b) An *empyema* occasionally points in the loin or even in the groin, but should be recognised by an examination of the thorax. (c) A chronic abscess, due to *appendicitis*, may present very similar signs to those of a deep-seated abscess in the ilio-psoas region on the right side, if it has not extended below Poupart's ligament. Careful examination, however, will demonstrate the upward extension of the abscess towards the spine in the latter case, whilst the previous history will differ considerably in the two conditions. The character of the pus is, moreover, a distinctive element, in that it has almost always an offensive smell when due to appendicitis, on account of the presence of the *B. coli*. (d) An *iliac abscess* may arise from a variety of conditions other than spinal disease, e.g., necrosis or caries of the ilium, or cellulitis in the tissues under the fascia iliaca. It is recognised by being, as a rule, more distinctly limited in extent than an ilio-psoas abscess, and by the absence of symptoms of spinal disease. (e) *Abscesses arising in connection with hip disease* occasionally point in the groin, but are easily distinguished from a psoas abscess by not extending upwards along the course of the psoas muscle, and by the evident signs of hip disease which are always present. (f) Diffused or *ruptured aneurysm* of the iliac artery may give rise to considerable difficulty in diagnosis, since a non-pulsating tumour in the course of the muscle is sometimes produced. The preceding history, the absence of fluctuation, the œdema and congestion of the leg, the interference with the pulse, and the rapid increase of the tumour, should indicate the nature of the case. (g) The diagnosis of abscess from *femoral hernia* is given elsewhere.

**Treatment**—The great essential in the treatment of spinal caries is absolute immobilization, perhaps associated with the application of some mechanical support, which takes the weight of the body from the seat of disease. This may be effected in any of the following ways.

(a) *By the Adoption of the Recumbent Posture*—The patient is kept in bed either in the prone or supine position, until the pain in the back

has diminished to such an extent as to warrant the application of a spinal support. In any but the youngest children the prone position on a suitably constructed couch may be adopted with advantage, since by this means the weight of the body is more completely taken off the spine, whilst local applications, such as blisters, or even the actual cautery, can be made. In many cases it is advisable to combine treatment in this fashion with the application of a removable poroplastic or leather spinal jacket. If thought desirable, extension by weight and pulley attached to the legs, as described at p 542, may also be employed, pain and irritation due to the pressure of the diseased bones one on the other are thereby minimized.

(b) *By the Application of Sayre's Plaster Jacket*—If the disease exists in the dorsal region, the trunk is encased in plaster of Paris, which should extend from the axillæ to just below the iliac crests. The patient is stripped to below the waist, and a closely-knitted woollen vest fitted to the body, and fixed by straps passing over the shoulders. A pad or folded towel is placed beneath it over the abdomen to allow for distension after meals, and in women similar smaller pads may be placed over the mammæ to protect them. Coarse canvas bandages, into the meshes of which plaster of Paris has been rubbed, are thoroughly soaked in water, to which a little salt or alum may be advantageously added, and then wound evenly round the body until a layer of five or six thicknesses is obtained. Over this a paste of plaster of Paris, prepared as described at p 471, is laid, until the jacket has attained sufficient thickness and consistency. It is allowed to dry before the patient's position is altered. In adults, where the disease is chronic and not acute, the jacket should be applied whilst the spine is extended by suspending the patient by the head and axillæ from a suitably arranged tripod. In children, or when the disease is acute, it will suffice if the parent or an assistant partially supports the patient from the armpits, or the apparatus can even be applied with the child in the recumbent posture. The jacket must be worn until all pain and evidence of active disease have disappeared, and after that the patient should be fitted with a poroplastic support for a time. In disease of the cervical or upper dorsal vertebræ, a special jury mast is required, in order to steady the head and take the weight off the spine (Fig 269). It consists of an iron rod, fixed to a plaster or poroplastic jacket, accommodating itself to the curves of the head and neck, above, it extends forwards as far as the vertex, and has attached to its upper end straps, which pass downwards beneath the occiput and under the chin.

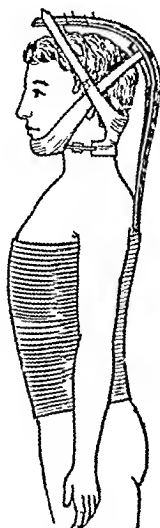


FIG 269 —SAYRE'S  
PLASTER JACKET  
WITH JURY-MAST  
FOR CERVICAL  
DISEASE

(c) *By the Use of Phelps' Box*—This plan of treatment is recom-

mended by Phelps of New York as specially valuable for children. The child is placed in a wooden box 6 inches deep, the lower end of which is divided into two portions, one for each leg, a suitable aperture being left at the junction of the divided parts for the passage of the excreta. Careful padding is applied to the whole of the interior, and the child is strapped and bandaged into this apparatus, and kept there for a period varying from six to twelve months. The whole trunk is thus absolutely immobilized, and the child can be easily carried about in his box, and taken into the open air. Extension can also be made, if necessary, by elastic accumulators attached to the head and neck, or legs.

(d) In very young children perhaps the simplest apparatus is a double Thomas's splint, with a suitable crutch above to fix and support the head.

During the whole course of treatment, the general condition of the individual must be carefully attended to, and suitable food and tonics administered. Wherever possible, the child should be taken regularly into the open air, or preferably sent to the seaside. When all symptoms of pain and irritation have disappeared, the patient may be allowed gradually to get about again with a mechanical support, and, indeed, this should not be dispensed with for twelve months after apparently complete recovery.

*Counter-irritation* is but seldom required. It may be useful, however, when severe pain exists in the early stages, especially in adults. The best means to employ is the actual cautery, either applying a button cautery at several spots on each side of the spine, or searing the skin longitudinally.

*Forcible straightening* under an anæsthetic has been recommended as a means of preventing or correcting the deformity of Pott's disease. A considerable number of cases have now been treated in this way, and with some degree of success, unfortunately, not a few deaths have been the direct result of this procedure, whilst the subsequent immobilization needs to be very prolonged, or the deformity will recur. Personally we consider that although it may be safe and desirable to straighten the back in a few cases, yet the risks are so great and the process so opposed to Nature's method of cure that unless future statistics show much better results than hitherto, the proceeding is scarcely justifiable. The most interesting point observed in this connection is the fact that cases of paraplegia seem to be immensely improved by this process, and that within a few days. It is also now maintained that no very great degree of force is required to do all that is desirable, the patient's head and feet are steadied by assistants making traction, and the surgeon merely uses as much force as can be applied by one hand placed over the curve.

The Treatment of the Chronic Abscesses is always a matter of anxiety, since, when once opened, they usually take a considerable time to heal, and if allowed to become septic the prognosis of the case is seriously affected. A general description of the methods employed has already been given at p. 167.

A *Retiopharyngeal Abscess* should always be dealt with from the neck, as described in Chapter XXIX

A *Dorsal, Lumbar, or Psoas Abscess* should be tapped with a large aseptic trocar and cannula, after the escape of the pus, the cavity is thoroughly washed out with a mild antiseptic lotion, or with sterilized salt solution at a temperature of 105° to 110° F. In the case of a psoas abscess, this irrigation may be combined with gentle massage of the abscess cavity, in order to detach as far as possible the pyogenic membrane, and to assist in the removal of curdy débris. When the lotion returns uncoloured, or but slightly tinged with blood, an ounce or two of a 10 per cent emulsion of iodoform in glycerine is injected, and diffused, if possible, through the abscess cavity by manipulation. The cannula is then withdrawn, and the external wound closed. Occasionally a cure can be obtained in this way by one tapping, but only when no active disease is present, and when the patient's general health is good, more commonly the fluid will re-collect, and the same process may need to be repeated two or three times. Sometimes the fluid finds its way along the track of the cannula, and a sinus results, such must be dressed antiseptically until cicatrization has occurred. The best position in which to tap a psoas abscess is at a spot just internal to the anterior superior spine, a small incision is made in the skin, sufficient to allow of the insertion of the trocar through the abdominal muscles into the cavity of the abscess, but the surgeon must make certain that the intestines have been previously displaced to one side. In a large abscess no fear need be entertained on this score, since the parietal peritoneum is always pushed inwards, but if there is any doubt, the abdominal muscles must be cleanly divided through an incision about 1½ inches long, so as to expose the abscess sac, a sinus is, however, more likely to form if this is done. Should the abscess point below Poupart's ligament, close to the saphenous opening, it may be necessary to open it there, perhaps in addition to tapping it in the usual place. It must be remembered that the femoral vessels are displaced somewhat and stretched over the sac, and precautions should be taken to prevent puncturing the vein, an accident which has occurred.

Some prefer to open the abscess freely, and scrape out its interior with a Barker's flushing gouge. Certainly by this means the tuberculous membrane and débris can be more thoroughly removed, but the sharp edge of the instrument is capable of doing a considerable amount of harm in this situation, and there is also more likelihood of a sinus remaining. Personally we are not in favour of its use for this purpose, and maintain that the method which we have advocated above is better, since there is less probability of the wound becoming infected with the tuberculous material, and hence of the formation of a sinus.

Occasionally it may seem advisable to freely open the sac of a psoas abscess, and where the disease originates in the lumbar vertebrae, it has been recommended by Sir F. Treves and others to cut down along the outer border of the erector spinæ, and deal with it

from behind. A vertical incision is made in this situation, down to the transverse processes, and the lumbar fascia and quadratus lumborum are divided by a transverse cut opposite the tip of one of these, the abscess sac is then easily reached and opened. The advantage of this plan is that the bodies of the vertebræ can be examined, and even scraped, or sequestra removed.

When symptoms of paraplegia arise in the course of Pott's disease, it is usually unnecessary to do more than maintain the immobilization of the spine, since, as already stated, the natural tendency of these cases is towards recovery. At the same time, extra precautions should be adopted in order to prevent bedsores over points of pressure. Should any difficulty in micturition arise, regular catheterism must be adopted, and the greatest care directed to the sterilization of the catheters, septic cystitis being always due to external contamination. In such cases it would be wise to purify the penis and urethra, and to keep the former wrapped in a dry aseptic dressing in the intervals between catheterism. A certain amount of forcible extension may be permitted in these cases, and will probably do good. Laminectomy (p. 717) is required in order to relieve pressure upon the cord in the following cases: (*a*) When septic cystitis or the existence of deep bedsores is threatening life, (*b*) when, in spite of prolonged rest, the symptoms persist or increase, (*c*) when paraplegic symptoms develop late in the case, and are possibly due to a development of fibro-cicatricial tissue outside the membranes (peri-pachymeningitis), (*d*) Finally, whenever the tuberculous process mainly affects the neural arches, there is no reason for not treating it by operation, if necessary.

**III Syphilitic Disease** of the spine develops in the shape of gummata, commencing beneath the periosteum which covers the bodies, it is of unfrequent occurrence, and gives rise to symptoms somewhat similar to those of tuberculous caries, from which the diagnosis is not always easy, apart from the history and its reaction to treatment. It usually occurs in adults, and is said to mainly affect the cervical vertebræ (Tubby), cases have been recorded in which a gumma opened into the pharynx, and portions of bone were discharged therein and expectorated. The co-existence of a syphilitic history and of specific lesions elsewhere may help one in coming to a decision as to the nature of the affection.

**Treatment** consists in the administration of suitable anti-syphilitic drugs, and in the use of a spinal support.

**IV Rheumatic Spondylitis** is a condition occasionally met with arising from the same causes, and associated with much the same phenomena as rheumatism elsewhere. It may involve either the ligamentous or muscular tissues, or may attack the intervertebral joints. Any part of the spine is involved, but perhaps the most marked features are presented in the cervical region. Considerable impairment in the movements of the head is then produced, and the neck may be laterally deflected, somewhat simulating torticollis. If untreated, adhesions form between the bones, and the loss of movement may be permanent. The treatment is of an ordinary anti-rheumatic nature.

The so called **Gonorrhœal Rheumatism** also affects the spine occasionally, and brings about much the same results

**V Osteo-arthritis** sometimes attacks the vertebral column, leading to destruction of the intervertebral discs and of the articular cartilages, together with erosion of the bones and the formation of osteophytic masses around. A large portion, if not the whole, of the spine is usually involved by this disease, and a prominent feature is the almost invariable supervention of ankylosis, either from ossification of the anterior or posterior common ligaments, or from interlocking or fusion of osteophytes. A marked kyphosis results, and great pain is present, sometimes due to pressure of the osteophytes upon the nerve roots. The disease may remain limited to the spine, or may involve other parts of the body. Finally, the process spreads to the articulations between the ribs and the vertebræ, and when these become fixed the respiratory movements are considerably impaired, and hence death is likely to ensue from pulmonary mischief. Treatment is as for similar disease elsewhere.

**Tumours of the Spine** are usually malignant in character, and most commonly secondary developments of cancer or sarcoma. Simple tumours, such as chondroma, osteoma and hydatid cysts, do occur, as also primary sarcoma. The chief symptoms are severe and localized pain which is constant, and unrelieved by rest in the recumbent posture, together with early excurvation and paraplegia. Deformity is, however, by no means constant. Neuralgic pain and motor spasms, due to involvement of the nerve roots, may considerably aggravate the patient's sufferings. These phenomena manifesting themselves in an adult should always suggest the presence of a morbid growth, and the more rapid the onset, the more likely is a diagnosis of malignant disease. Treatment necessarily is but rarely feasible, although an exploratory operation is quite justifiable if the disease is primary and the patient not profoundly cachectic.

**Tumours of the Spinal Cord and Membranes** develop in several situations, and the symptoms are thereby somewhat modified. (a) *Outside the spinal dura* Lipoma and sarcoma are here most often seen, and the symptoms of cord pressure, such as loss of power and sensation, are preceded by those of spinal irritation, e.g., neuralgic pain, increased on movement and are often limited for some time to one side. Multiple neuro-fibromata of the nerve roots are by no means uncommon. (b) *They may grow from the inner aspect of the dura mater*, and thus produce symptoms of cord pressure and meningeal irritation concurrently. Sarcoma, endothelioma, fibroma and gumma are the commonest forms of neoplasm in this situation. (c) *From the spinal cord itself* myxoma, psammoma, and sarcoma may originate. The symptoms are those of paraplegia combined with some localized and referred pain or tenderness and either bilateral from the start or sometimes of the crossed type, anæsthesia being marked on one side of the body, and paralysis and hyperæsthesia on the other, i.e., on the side of the tumour. Left to themselves, patients suffering from any of these growths are certain to die and hence an exploratory laminectomy, with a view to removal of the growth, if practicable is always indicated when a diagnosis has been effected. The possibility of the disease being syphilitic in origin must not be overlooked and hence a preliminary thorough course of iodide of potassium should always be instituted before operating. The results hitherto obtained have been distinctly encouraging although many of the cases are left till too late and the mortality is certain to be high.

The only inflammatory disease of the cord which need be alluded to here is one the results of which have already been mentioned constantly in the chapter dealing with the deformities of the body (Chapter XVIII), viz. **Infantile Paralysis**. This condition is due to an inflammation (probably infective) of the

anterior cornua of the gray substance of the cord (anterior polio myelitis), as a result of which the multipolar ganglion cells situated therein are destroyed. The symptoms come on abruptly, and are often introduced by a short febrile attack, paralysis shows itself at once and quickly attains its maximal proportions being possibly followed by a certain amount of recovery. The portions that remain paralyzed early lose their nutrition, owing to the destruction of their trophic ganglionic centres, and become cold and bluish in colour. Finally, deformities due to the unbalanced action of opposing groups of healthy muscles may appear whilst the development and growth of the affected limbs are impaired. The distribution of this affection is very variable, but, speaking generally, the legs are most commonly affected the lower halves, and not the upper, being mainly involved. Various forms of talipes may result therefrom, as also weak and flail-like conditions of the knee and ankle. When the thigh is included, the quadriceps extensor and adductors are usually picked out. In the arm the deltoid is most often paralyzed, and after this the muscles on the extensor side of the fore arm, excluding the supinator longus. The face and neck are rarely involved but the abdominal and back muscles may be attacked. The Treatment in the early stages is directed towards improving the general health, and maintaining the nutrition of the affected muscles as far as possible by electricity and friction. In the later stages when deformed or weak and flail-like limbs have resulted, various means may be adopted in order to improve the functions of the part.

(a) *Mechanical support* is often needed and this must be carefully regulated, in order to assist and not to hamper the movements of the individual by its unnecessary weight. In paralytic talipes, irons fixed to the boots and rising above the knee or even sometimes running up to the pelvis, are frequently required.

(b) *Tenotomy*, or division of muscles or fasciæ, may also be needed in certain deformities.

(c) *Tenoplasty* or the grafting of a healthy tendon into a paralyzed one, has been occasionally utilized, as also the transplantation of the bony attachments so as to put the relaxed and weak muscles on the stretch.

(d) *Arthrodesis*, or the fixation of joints is a useful proceeding under circumstances where the unnatural mobility is difficult to control, or would necessitate considerable increase in the weight of the apparatus required, or where from the poverty of the patient, the apparatus cannot be obtained. It is especially serviceable in cases where two joints in a limb are flail like one of which may then be ankylosed with advantage. The operation consists in a modified excision, the cartilage alone being sawn or scraped from the ends of the bones, but it must always be remembered that the reparative activity in paralyzed limbs is small.

(e) Where the whole limb is hopelessly paralyzed and a great inconvenience to the patient, *amputation* is often the best practice.

## CHAPTER XXV

### AFFECTIONS OF THE SCALP AND CRANIUM

#### Injuries of the Scalp

WOUNDS of the scalp are produced by either sharp or blunt instruments, by falls on the head, or by gunshot injuries. From the tenseness of the scalp over the cranium, it often happens that a blunt weapon, such as a policeman's truncheon, will cause a wound nearly as cleanly cut as if it had been made with a sharp instrument. The depth to which the injury extends is a most important element in these cases and, so long as it is limited to those parts superficial to the occipito-frontalis aponeurosis, but little harm is done, if, however, the layer of loose cellular tissue between the aponeurosis and the pericranium (the 'dangerous area') is opened up and infected, cellulitis (p 74) is likely to ensue, and fatal consequences may result. The superficial extent of the wound is a matter of little moment, since the vascular supply is so good that sloughing is uncommon, a large portion of the scalp may be torn up and bruised, and yet, if it is carefully washed and rendered aseptic, there is every probability that it will retain its vitality.

The **Treatment** of scalp wounds is conducted on exactly the same lines as that of wounds elsewhere, that is to say, after efficient purification they may be stitched up, provision being made for drainage, if necessary. The hair should, of course, be cut away from the neighbourhood of the wound, and an antiseptic dressing applied. Hæmorrhage from the scalp may be severe, owing to the density of the scalp tissues, which prevents contraction and retraction of the divided vessels. For a similar reason it is sometimes difficult to secure them by ligature, and a suture can then be passed under the vessel in such a way as to control it.

Contusions of the scalp may occur without solution of continuity of the surface, and result in the formation of bruises or hæmatomata. A similar condition is found in new-born infants, it is due either to pressure or injury to the head during its passage through the mother's pelvis, or to the compression of obstetric instruments. Three varieties of the so-called *cephal-hæmatoma* have been described, viz (a) the *Superficial*, which, confined to the dense subcutaneous tissue, is necessarily small and limited. (b) The *Subaponeurotic* occupies the



loose tissue under the aponeurosis, and is only limited by the attachments of this structure. It forms a large, soft, fluctuating swelling, upon which the scalp appears to float, bagging down over the eyes or occiput. (c) The *Subperiosteal* is limited by the pericranium dipping down into the sutures around the bone with which it is connected. Most commonly it forms over one of the parietal bones, presenting a soft, fluctuating swelling, which soon gains an indurated margin owing to a deposit of fibrin, and in this condition may simulate a depressed fracture of the skull, inasmuch as the cup-like fluid centre allows the finger to sink in and touch bone below. It is not difficult to recognise, however, since the indurated margin can be readily indented by the finger, whilst the edge is definitely raised above the surface of the cranium, and hence the sensation of depression of bone felt through the fluid is only apparent. In old standing cases ossification of the walls of this cavity has even been known to occur. *Treatment*—All that is required is the application of evaporating lotions. There is hardly ever any need to lay open or drain these swellings.

### Diseases of the Scalp

It would involve a needless amount of repetition to mention and describe in detail all the many conditions which may be met with in the hairy scalp, and therefore it is only necessary to deal with those which are of the greatest importance.

**Suppuration** is of common occurrence, arising mainly from external infection, but being occasionally due to disease of the subjacent bones. The extent of the abscesses is limited by the same anatomical features as obtain in connection with hæmorrhage. Thus, a *subcutaneous* abscess is necessarily small in size, owing to the density of the tissues in which it is located, it arises most frequently as a result of eczema or impetigo, and is often due to the presence of pediculi, or to the action of irritants used in the cure of ringworm. A *subaponeurotic* abscess usually results from a septic penetrating wound, and is associated with cellulitis. A *subperiosteal* abscess is rarely seen except in connection with injury or disease of the bony calvarium, the pus is limited to the affected portion of bone.

**Erysipelas** and **Cellulitis** have been described elsewhere (pp 74 and 117).

**Tumours** occurring in and under the scalp may be considered according to whether they pulsate or not.

I **Pulsating Tumours of the Scalp** arise from three distinct sources.

1 They may be of *Extracranial* origin, and then are mainly associated with the superficial bloodvessels. (a) *Ordinary aneurisms* of traumatic origin are not uncommonly seen, they rarely attain any considerable size, and are readily dealt with by excision. (b) *Arterio-venous wounds* give rise either to an aneurismal varix or to a *varicose aneurism*. They usually involve the temporal trunk, and their symptoms and treatment require no special notice. (c) A curious

dilated and tortuous condition of one of the scalp arteries, most often the temporal, is occasionally seen, and is known as an *arterial varix*, it may be treated by complete excision (d) A *nævus* situated over the anterior fontanelle may derive a communicated impulse from the subjacent dura. It has no special features apart from this, and is to be treated in the same way as other *nævi* of the scalp, viz, by excision or electrolysis (e) A much more serious and interesting phenomenon than any of the others is that known as a *cirsoid aneurism*.

**Cirsoid Aneurism** is more frequently met with in the scalp than elsewhere, and mainly involves the temporal region, but may also spread in all directions, even downwards into the neck. A tumour of greater or less size is seen under the skin, consisting of distended, tortuous, pulsating, bluish-looking vessels, the arteries opening directly into cavernous spaces without the intervention of capillaries, it is easily emptied by pressure, but quickly refills, owing to the abundant arterial supply. The rate of growth is variable, and the patient often complains of headache and giddiness, the skin becomes thin and atrophic, the hair falls out, and finally ulceration may occur, the patient probably dying from hæmorrhage. The Treatment is eminently unsatisfactory, complete excision being the ideal cure, but this in the worst cases is impracticable. If it be attempted, the incisions should be made wide of the disease, and the supplying vessels secured, if possible, between double ligatures before dividing them, if this precaution is not adopted, frightful hæmorrhage may result. It is necessary in some cases to deal with the tumour in separate segments, allowing time between the operations for the patient to recover from the loss of blood. Probably *electrolysis*, combined with ligature of the main nutrient vessels, holds out the best chance of success. (For methods of electrolysis, see p 353)

2 The chief pulsating tumours of *Cranial* origin are as follows

(a) Sarcomata arising from beneath the pericranium or from the diploe (p 747) (b) Secondary nodules of cancer may develop in the diploic tissue, those due to the form known as thyroid cancer are specially noted for their pulsation (c) Aneurism by anastomosis occasionally develops in the cancellous tissue of the diploe, and gives rise to pulsation, which can be felt when the bones are sufficiently expanded and atrophied (p 610)

3 Pulsating swellings of *Intracranial* origin include the following conditions. Encephalocele (*vide infra*), traumatic cephal hydrocele (p 748), hernia cerebri (p 795), and sarcoma of the dura mater (p 747)

**II Non-pulsating Tumours of the Scalp**—Almost any of the ordinary connective-tissue or epithelial growths may occur, but the following are the more important

**Papillomata** are not uncommon in the form of small hard warty outgrowths, giving rise to but little inconvenience, unless situated on some spot where the hat rests. They are easily removed

**Epithelioma** also occurs, arising either from an irritated papilloma, or possibly in connection with a sebaceous cyst. As soon as a

diagnosis is made, the growth should, if possible, be extirpated, and the resulting raw surface may either be left to granulate, or dealt with by Thiersch's method of skin-grafting

**Fibroma** is either seen in the shape of a localized development of hard fibrous tissue, and often growing on the forehead where the hat crosses it, or it may attain much larger dimensions, involving perhaps half the scalp, and giving rise to an irregular nodulated outgrowth of soft fibro cellular tissue, which has sometimes been termed a *pachydermatocoele* (p 189) Either form may be dealt with by excision

**Sarcomata** of various types involve the scalp, presenting as large fleshy tumours which may pulsate or fungate They usually develop rapidly, but are limited for some time by the aponeurosis of the occipito-frontalis, glandular infection is uncommon In their removal it is useless to attempt to save the aponeurosis, the whole thickness of the scalp must be sacrificed, and the incisions should be wide of the growth The wound is allowed to granulate, or covered in with Thiersch grafts

**Dermoid Cysts** are by no means uncommon in this region, their favourite situation being near the outer canthus, the temple, or the root of the nose For a general description, see p 215 They do not attain any great size, and may not become evident till after puberty The underlying bone is often hollowed out from a defective development of the mesoblastic tissues around them, and a congenital opening may even exist through which a narrow neck passes, bringing the cyst into direct connection with the dura mater The *treatment* consists in removal, but it is advisable to delay this till after puberty if the tumour seems at all fixed to the skull, or if the bone is felt to be defective beneath it, as in such cases the communication with the interior of the cranium is often shut off by that time

**Sebaceous Cysts** (p 403) find their most usual situation in the scalp, where they not only are frequently multiple, but also may reach a considerable size Their removal is best accomplished by transfixion, squeezing out the contents, and picking out the cyst wall by a pair of forceps without dissection The wound is closed by one or two stitches

**Sebaceous Adenoma** is most frequently seen on the scalp (p 404)

## Affections of the Cranium

### I Congenital Affections

1 **Meningocele, Encephalocele, and Hydrencephalocele** consist of a protrusion of the dura mater, with or without part of the brain, through an opening in the cranial wall They are due to defective intrusion of the mesoblastic tissues outside the primitive cerebral vesicle, so that part of the brain or its membranes remains superficial and extracranial They occur most frequently at the root of the nose, and in the occipital region (Fig 270), occasionally at the anterior or lateral fontanelle, or at the base of the skull A *Meningocele* is simply a protrusion of the brain membranes containing

cerebro spinal fluid It forms a soft, rounded, fluctuating swelling, attached to the skull by a base of greater or less size, and covered by skin, which may be thick and healthy, or thinned, bluish, and translucent when the tumour is large The vessels present in the skin are often dilated and *nævoid* It increases in size and tension on any expiratory effort, such as coughing or crying, and it may be partially reducible, thus allowing the margins of the opening in the cranium to be defined Symptoms of cerebral compression, convulsions, etc., are likely to be produced by such manipulation

An *Encephalocele* is a similar type of tumour, but contains brain substance, and pulsates nearly synchronously with the heart, it is most commonly situated at the back of the skull A *Hydroencephalocele*, or Meningo-encephalocele is a condition in which the tumour contains both brain substance and fluid

Two varieties have been described—one in which there is a small pro-

trusion of the brain associated with an ordinary meningocele, and the other in which the fluid is contained in a cavity communicating with one of the ventricles, and covered by a thin layer of brain substance They are usually of considerable size, constituting a type of hydrocephalus, and are situated in the occipital region, either above the tentorium, and then possibly associated with distension of the posterior cornu of one of the lateral ventricles, or below that structure, the osseous defect extending in some cases as far as the foramen magnum, and a portion of the cerebellum being within the sac

The **Prognosis** of these conditions is exceedingly grave Fortunately, many of the subjects are born dead, or die soon after birth In the more severe cases, idiocy and microcephaly are not uncommonly associated, whilst sometimes true internal hydrocephalus is present The protrusion may increase steadily in size and finally burst, causing death by purulent meningitis, or in more favourable cases it may remain stationary In a meningocele, the subsequent growth of the cranial bones may suffice to close the communication between the interior and the tumour, which thus becomes shut off, and remains as a cyst like swelling, with the base fixed, and without pulsation or respiratory impulse

**Treatment**—Most cases should be left alone, but if the tumour is steadily increasing in size, aseptic puncture and subsequent com-



FIG 270 —CONGENITAL ENCEPHALOCELE OF THE OCCIPITAL REGION (TILLMANN'S)

pression may hinder the process, a pure meningocele may possibly be cured in this way. Where the communication with the skull is small, it may be feasible to excise the tumour, taking special care to suture the base securely, and attempting when practicable to make good the cranial deficiency by osteoplasty.

2 In infants the ossification of the bones may be incomplete, constituting what is known as *aplasia cranii congenita*. It is said to be due to foetal rickets, arising from a cachectic condition of the mother. Great care is needed in dieting such children and protecting them from injury. Occasionally a similar atrophic condition of the bones may persist through life, exposing the patient to increased risk from injuries which otherwise would do but little harm.

3 Localized congenital atrophy of the bones is also sometimes met with in connection with dermoid cysts, as mentioned above.

II **Acquired Affections** of the skull are atrophic, hypertrophic, inflammatory, or neoplastic in nature.

**Acquired Atrophy** of the skull occurs in many forms.

(a) *Craniotabes* is a condition met with during the first year of life, usually as a result of inherited syphilis (p. 597).

(b) *Senile* atrophy may affect the whole cranium, which becomes thinned and rarefied, or it may be localized, as pointed out by the late Sir G. M. Humphry,\* to the parietal bones, constituting hollow depressions which extend antero-posteriorly. No symptoms are caused thereby, but the patient runs a certain increased risk from injuries to the head.

(c) Localized loss of substance may result from the pressure of tumours, such as Pacchionian bodies and aneurisms, or from necrosis, or traumatic and operative lesions. If these are at all extensive, the cerebral pulsations can be felt distinctly through the skin. It is then advisable to provide the patient with some guard to protect him from injury. This may be accomplished by means of a metal plate worn over the scalp, but of late years operative measures have been introduced to obviate this. *Autoplasty* is the term applied to a proceeding whereby the defect is closed by a plate of bone removed from the patient's own skull. A suitable scalp flap is turned down, and then a portion of the outer table is chiselled up sufficient in size to close the aperture. The pericranium is utilized on one side as a pedicle, and by means of this it is stitched down into the gap, the margins of which have been previously freshened. By *heteroplasty* is meant a similar proceeding when the hole is closed by a plate of gold, platinum, or vulcanite let in under the pericranium or inserted between the dura mater and the cranium. The results of these procedures have been on the whole satisfactory.

(d) *Chronic Internal Hydrocephalus* is always associated with atrophy and thinning of the cranium, it may be congenital, or may commence early in life. It is produced in almost all cases by a distension of the lateral ventricles with fluid, the result of congenital malformation, or of inflammatory affections, causing exudation from the choroid

\* *Med.-Chir. Trans.* 1890, p. 327.

plexuses, pressure upon the veins of Galen or inferior longitudinal sinus, and possibly closure of the foramen of Majendie. The head becomes more and more distended, the bones expanded and thinned, and the sutural areas increased, whilst the brain is subjected to such pressure as may be incompatible with life. Fluctuation is distinctly felt, and the bones may crackle under the fingers, the face looks abnormally small, and the eyes protrude, owing to the depression of the orbital plates. *Treatment*—The ventricles may be tapped at a spot some little distance from the median line, and a considerable amount of the fluid withdrawn, whilst elastic pressure is subsequently maintained, but as the cause cannot be removed, recurrence is almost inevitable. It has recently been demonstrated that there is a direct absorption of fluid into the veins from the subdural space at any tension above the venous pressure, and hence it is suggested that, by establishing a communication between the ventricular and subdural spaces, the excess of fluid in hydrocephalus might be absorbed. This has been attempted in two or three cases, and the results have been encouraging, but of course, to be of any value, it must be undertaken before the cerebral cortex has been so thinned as to interfere with its functional activity.

(c) By *Micrcephaly* is meant a condition of diminished size of the cranial cavity due to premature ossification of the sutures, and resulting from non development of the brain. It is usually associated with idiocy, and possibly with cretinism. Attempts have been made to relieve this by the operation of linear craniectomy or removal of portions of the cranium, so as to allow of the expansion of the brain. Temporary improvement has followed in a few cases, but even then the final result is extremely uncertain, most of the patients relapsing owing to the contraction of the dense cicatricial material which replaces the bone, and to the atrophic condition of the brain.

**Hypertrophic Changes of the Skull** result from simple chronic inflammatory affections, or from injury, etc. We have already alluded to the special types of enlargement seen in inherited syphilis (p 596), rickets (p 598), osteitis deformans (p 603), and acromegaly (p 605). In leontiasis ossea (p 816) the cranium also becomes thickened and enlarged, but the cranial cavity is encroached on, constituting what is known as *concentric* hypertrophy, in contrast to most of the other forms, which are *eccentric* in type.

**Inflammatory Affections of the Cranial Bones**—The cranium is liable to any of the diseases which generally occur in bone.

1 **Acute Periostitis, or Pericranitis**, is usually septic in origin, following cellulitis of the scalp, it is likely to result in necrosis of the outer table.

2 **Acute Infective Osteo-myelitis**, or acute necrosis, consists of an acute inflammation of the diploe, due to pyogenic organisms, and either following a septic scalp wound, a compound fracture, or a simple contusion of the bone in a person of low germicidal powers. The symptoms and signs are those generally characteristic of the disease, being ushered in by a rigor, followed by headache, fever,

and the development of a localized œdematous swelling, known as 'Pott's puffy tumour'. The pericranium is stripped up by diffuse suppuration beneath it, and an abscess often forms between the bone and the dura mater. Necrosis of the whole thickness of the skull is likely to follow, extending over the whole bone involved, but usually limited by the sutures. Separation of the sequestrum is *slow*, and accompanied by little or no new formation of bone. Pyæmia and extension of the inflammation to the membranes, venous sinuses or brain, are the chief dangers arising from it. The prognosis is always grave. The *Treatment* consists in free external drainage, but in addition it is necessary to remove the outer table with chisel and mallet to the utmost limits of the disease, and thoroughly to scrape away all the septic diploe, disinfecting the parts beneath with pure carbolic acid. If signs of subcranial suppuration ensue (p 781), the inner table must also be removed.

3 **Chronic Periostitis** of the cranium is occasionally met with in the form of a node. It is usually the result of some long-continued irritation, such as carrying baskets or weights on the head. *Treatment* consists in the removal of the irritation, and there is no objection to chiselling away the node, if necessary.

4 **Tuberculous Disease** of the cranial bones is not common, it occurs as a primary phenomenon, or is secondary either to a cutaneous lesion, such as lupus, or perhaps more commonly to a meningeal focus. It may start in the periosteum or diploe, leading to the formation of a node or perhaps to expansion of the bone, and followed by suppuration and caries. When of meningeal origin, there is a considerable amount of erosion of the inner table, and possibly some necrosis, sooner or later the outer table is perforated and a subpericranial abscess forms. The amount of mischief in the outer table is no criterion of the extent of the disease within, and hence very thorough exploration is necessary. The prognosis in this variety is not good. The external orbital margin in the neighbourhood of the external angular process of the frontal bone is rather a favourite situation for the disease, which is then often accompanied by other manifestations.

5 **Syphilitic Disease** of the cranium, on the other hand, is exceedingly common, occurring usually in the tertiary stage, and affecting most frequently the frontal and parietal bones. It has been already described (p 595).

**Tumours of the Cranial Bones** — The chief Tumours affecting the calvarium are osteomata and sarcomata.

**Osteoma** of the cranium occurs as a localized overgrowth of compact bone from the outer surface of the calvarium, from the inner, or from both. The frontal bone and external auditory meatus are the sites of election. If arising externally, a smooth, rounded, globular swelling is produced, hard to the touch, quite painless, and attached to the subjacent bone by a broad base, more than one may be present. If the main growth is internal, symptoms of cerebral irritation or pressure may be produced. Osteomata are to be

distinguished from inflammatory hyperostoses (usually of syphilitic origin) by their sharp limitation, absence of pain, and slower progress, whilst osteo-sarcomata are commonly rapid in growth, painful, and of unequal consistency in different parts. *Treatment* is rarely necessary. Small growths may be encircled in the crown of a trephine and thus removed. Large ones must be dealt with by a dental engine. No attempt should be made to chisel away these growths, as serious cerebral concussion may follow the prolonged use of the chisel and mallet against the skull.

**Sarcoma** of the cranium originates either from the pericranium, the diploe, or from the dura mater.

The *extra-* or *peri-cranial* variety consists of a round or spindle-celled tumour growing from the pericranium, and possibly attaining a considerable size. It may contain a certain amount of ossific deposit, or the tumour remains of a soft consistency, and then often pulsates. The subjacent bone is sometimes absorbed, and the dura mater affected secondarily. General infection of the system follows.

*Central* sarcoma of the cranium starts from the diploe as a myeloid tumour. It does not grow so rapidly as the other forms, it is single, and generally covered with a layer of expanded bone, which gives a sensation of eggshell crackling to the finger. Later on it involves the dura mater and skin, and may fungate.

*Sarcoma of the dura mater* may be attributed to some injury to the head, and is characterized by the occurrence of severe cerebral symptoms, *e g*, intolerable localized headache, epileptic fits, double vision, optic neuritis, etc., prior to any evident appearance of a tumour. Gradually the bones become expanded and perforated, and a soft and exceedingly vascular pulsating growth is felt beneath the scalp. This fungates sooner or later, and possibly the meningeal cavity is laid open by ulceration, death from septic meningitis, cerebral compression, or exhaustion ending the chapter.

*Treatment*—These cases have usually gone too far before being recognised. If an early diagnosis can be arrived at, free removal may be undertaken by trephining and the use of the chisel, sharp spoon, or gouge.

### III Traumatic Affections of the Cranium

**Contusions of the Cranial Bones** apart from fracture may lead to serious results. 1 Many of the inflammatory conditions of bone just described may be originated, *e g*, if the patient is in a condition of low germicidal power, acute osteo myelitis may follow, or chronic sclerosis and overgrowth of the bone, local or diffuse, may supervene. Syphilitic or tuberculous manifestations may be similarly lighted up if the patient is the subject of either of these diseases. 2 In addition to such osseous conditions, pus may form within the cranium outside the dura mater (*subcranial abscess*, p 780), and necessitate trephining. 3 The dura mater may be detached by a simple contusion, leading to meningeal hæmorrhage (p 779). 4 Any of the cerebral lesions detailed hereafter may be produced. Contusions of the cranium



must obviously never be treated lightly, even when they are associated with unbroken skin, much more are they serious when compound, owing to the risks of infection

Fractures of the Skull may be described for convenience under the following headings *Fissured Fractures of the Vault*, *Fractures of the Base* (usually fissured), and *Depressed or Punctured Fractures*

1 **Fissured Fractures of the Vault** are always due to external violence, direct or indirect. In the former case the skull first yields at the injured spot, but the fissure may extend from it for some distance, in the latter the fracture results from the yielding of the skull when compressed beyond its natural limits of elasticity

A simple fissure gives rise to no symptoms indicating its presence with certainty. There may be some amount of superficial ecchymosis, but nothing more definite. When compound the line of fracture may be seen as a red streak, or even felt with the finger as an irregular ridge. It consists of a mere longitudinal fissure, or may be starred, if uncomplicated, it is of but little importance, and needs nothing beyond general treatment—of course, the greatest care being taken to ensure asepsis. Occasionally, however, an osseous growth forms from protuberant callus on the inner aspect of the cranium at the site of fracture, and gives rise to traumatic epilepsy or insanity  
(p 794)

**Traumatic Cephal-hydrocele** is the name given to a rare condition following simple fractures of the vault, especially in children. It is characterized by the formation of a fluid swelling under the scalp, which pulsates synchronously with the heart beat, and has a definite impulse on any expiratory effort, it varies in size from time to time, and is sometimes partially reducible. It contains cerebro-spinal fluid, and communicates with either one of the lateral ventricles or the subarachnoid cavity. In one case it was proved on operation to be connected with an arachnoid cyst, due to a localized subarachnoid hæmorrhage. Probably it is wise to leave this condition alone, although, if one could be tolerably certain that the ventricle was not affected, it might be laid open and drained

2 **Fractures of the Base of the Skull** are almost always fissured, only occasionally punctured or depressed

**Causes**—(a) *Violence may be directed to the vertex or to some part of the cranial convexity*, as from a blow or fall upon a hard substance. There has been a good deal of discussion as to how a fall on the vertex causes fracture of the base. The old idea of contrecoup—i.e., that the force was transmitted from one side of the skull to the other, producing a fracture—may be decently buried and forgotten, whilst two main theories still hold the field, each being probably responsible for a certain number of cases. (1) Aran's theory of *irradiation* maintains that a fracture of the base is always due to direct extension of the fissure from the injured vertex, a proposition probably quite true in many cases, but insufficient to explain all. (ii) A more recent idea, known as the *bursting or compression theory*, is based on the fact that the cranium is not a solid and totally unimpressionable body,

but is highly elastic, as has been proved by the observation that hair and even pieces of skin have been found nipped in a fissured fracture of the vault, which had evidently gaped open and closed again. Severe compression necessarily diminishes the diameter of the skull along the axis of greatest pressure, making it bulge in other diameters, and if this distension exceeds the limits of elasticity, the bone gives way. The direction of fractures produced in this manner varies. Most commonly the lines of fracture are parallel to the direction of the compressing force, the bone thus bursting open along its convexity (fracture by bursting), less frequently it gives way at right angles to the direction of the force where the bulging is greatest (fracture by compression). Inasmuch however, as the force is transmitted equally in all directions, the weakest and least elastic part is most likely to give way, viz., the base. Whether these ideas are justified is a question, certainly the figures quoted by Phelps indicate that irradiation is responsible for a very large proportion of fractures of the base. (b) *Direct or indirect injury* to the base of the skull is undoubtedly the cause of a certain number of fractures, and some of these are depressed, and not fissured, in character. Thus, the point of an umbrella or stick may be thrust through the upper wall of the orbit, or up the nose through the cribriform plate of the ethmoid, the condyle of the jaw may be driven through the glenoid cavity into the middle fossa by a blow on the chin, direct injury from a fall or a stab may penetrate the occipital bone, whilst a gunshot wound in the mouth is another illustration of this kind of injury. (c) *The impact or resistance of the vertebral column against the occipital condyles* produces fractures in the posterior fossa which radiate from the foramen magnum, and may even occasion a ring-shaped fracture around it (Fig 271). They result from falling on the vertex into a soft mass, e.g., a bale of wool, or by alighting from a height on the heels or nates.

The fracture may run in any *direction*, longitudinal, oblique, transverse, etc., according to the direction of the compressing or fracturing force, and it may affect any part of the base, either being limited to one of the fossæ or involving all, it may follow the sutural lines in part, but it is no uncommon thing to see even the dense petrous bone traversed by a fissure (Fig 272). Naturally, transverse fractures tend to be limited to one of the fossæ, whilst a longitudinal fissure may involve them all.

Some fractures of the base of the skull are simple in nature, but the majority are *compound*. In the anterior fossa the fissure extends through the cribriform plate and nasal mucosa, and then lays open the nose, or a communication may be established with the external air through a penetrating wound in the orbit, or through the ethmoidal or sphenoidal sinuses. In the middle fossa a fracture through the base of the sphenoid opens the roof of the naso-pharynx, or the fracture may involve the tympanic cavity. In the posterior fossa the basi-occipital may be broken, and the naso-pharynx again opened, although the fracture here is more commonly simple.

\* 'Traumatic Lacerations of the Brain' London Henry Kimpton 1898

Fractures of the base of the skull, though very serious, are by no means necessarily fatal, and since the introduction of antiseptic work the results have immensely improved. The main *dangers* to be apprehended are (i) Damage to the base of the brain, including the pons and medulla, especially in cases where the foramen magnum is splintered from the impact of the spine against the condyles, (ii) hæmorrhage arising either from the venous sinuses, or from the meningeal or cerebral arteries, and (iii) septic meningitis, due to the fact that the injury not only fractures the bones, but also lays open the dura mater, a grave addition to a compound fracture.

The Signs of a fractured base are sometimes exceedingly equivocal, but for convenience may be arranged under four heads

(1) Signs of severe cerebral mischief, such as concussion of the brain

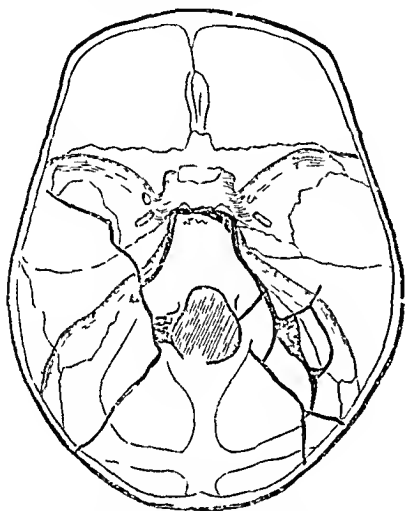


FIG. 271 — FRACTURE OF THE BASE OF THE SKULL FROM FORCE ACTING AGAINST THE OCCIPITAL CONDYLES, AND PRODUCING ALMOST AN ANNULAR FRACTURE AROUND THE FORAMEN MAGNUM (TILLMANN'S)

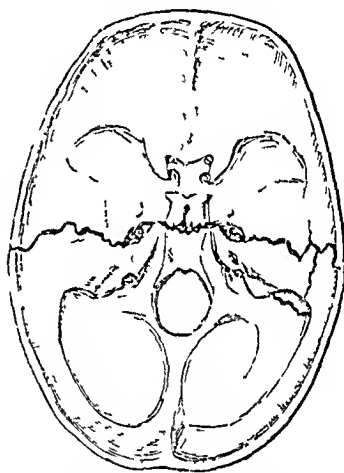


FIG. 272 — TRANSVERSE FRACTURE ACROSS THE BASE OF THE SKULL

and prolonged unconsciousness. This is, however, by no means always present, thus, in a case we had in hospital some years back, the patient was capable of going about his work for ten days after the accident.

(2) Hæmorrhage manifests itself in various directions, according to the situation of the fracture.

In the anterior fossa there may be free bleeding from the nose, owing to the fracture extending through the cribriform plate of the ethmoid, but a portion of the blood may pass backwards into the pharynx, and, being swallowed, is perhaps subsequently vomited. More often, however, the line of fracture runs across the roof of the orbit, causing escape of blood into the areolar tissue of this cavity. The ecchymosis shows itself as a gradually developing subcutaneous distension,

involving the lower lid, bluish-purple in colour at first, but passing later through the other stages of a bruise, there is probably no contusion of the skin, as in the ordinary black eye, which is at first reddish-purple, the ocular conjunctiva is considerably involved, but the effusion rarely extends above the cornea, and its posterior limits cannot be seen. The bleeding usually arises from laceration of the dura mater and bone, but, when abundant, may come from the cavernous sinus, and the eye may even be pushed forwards (proptosis), in some cases pulsation is to be felt within the orbit, and then a traumatic orbital aneurism or aneurismal varix is present.

In the *middle fossa* the blood may enter the nose or mouth, a part being swallowed, but more commonly it escapes from the ears. If abundant, it probably comes from one of the vascular channels at the base of the brain, but if only slight in amount and of short duration, it may be induced by any of the following lesions, as well as by a fractured base, viz (a) A simple rupture of the membrana tympani, (b) separation of the cartilage of the pinna, with tearing of the lining of the external meatus, (c) fracture of the anterior and lower part of the tympanic plate, as by a blow on the jaw, which drives the condyle forcibly against it.

In the *posterior fossa* the bleeding is usually subcutaneous, showing itself around the mastoid process, and extending downwards amongst the muscles at the back of the neck.

(3) *Discharge of cerebro-spinal fluid* is an indication that a communication exists with the subdural space. The fluid may be discharged from one or both ears, but has also been met with coming from the nose or cranial vault, when from the ear, the dura mater has probably been laid open through the prolongation which accompanies the auditory nerve in the internal meatus by a fracture traversing the petrous bone. It is watery and limpid in character, with a specific gravity of about 1.005, slightly alkaline, and containing a fair quantity of chloride of sodium, with traces of albumen, and of a substance which, like grape-sugar, reduces cupric salts on boiling. At first it may be slightly blood-stained, but this soon ceases, the fluid becoming quite clear. The amount discharged may be small, but not unfrequently it comes away in large quantities, soaking the pillow and dressings, and, indeed, can sometimes be caught in a test-tube as it trickles from the meatus. As a rule, the flow commences soon after the injury, and quickly ceases, but a few years back a curious case occurred, under the care of Lord Lister at King's College Hospital, of a man who had fallen backwards off a high bed upon his occiput, he was temporarily stunned, but returned to bed, and, on awaking the next morning, found that both eyes were black. He continued work for ten days, complaining, however, of headache, and at the end of that time of earache, which grew steadily worse, until relieved by something giving way in his left ear. This was followed by a copious discharge of cerebro-spinal fluid, which was maintained for some time, and from the after-history there can be no doubt that it was due to a fractured base.

Escape of brain substance from the ear has also occurred in a few instances, most of them fatal

(4) *Lesions of the nerves* issuing from the base of the skull are occasionally produced For symptoms, etc, see Chapter XV The nerve most commonly involved is the facial, as it passes through the aqueductus Fallopi, the paralysis may develop either immediately, or more often about the second or third week after the injury, disappearing in about a month, and then evidently due to its implication in the callus A certain amount of deafness is often associated with it from injury to the portio mollis

The Prognosis of fractured base has much improved during recent years, as a result of the application of antiseptics to the auditory meatus If the patient escapes death from cerebral complications, the bones of the skull unite rapidly, and a good result may be expected, although troublesome sequelæ may follow, from the injury sustained by nerves or vessels, or their compression in callus or new bone

**Treatment**—Seeing that the chief danger to the patient arises from septic contamination of the meninges, the greatest care must be directed towards preventing decomposition of the discharges Unfortunately, it is impossible to apply dressings to the naso-pharynx, or even to wash it out thoroughly with antiseptics, and the only satisfaction about such cases is that the rarity of the loss of cerebrospinal fluid suggests that the membranes of the brain are not very often damaged in that situation, whilst it has also been shown that in the majority of cases the upper part of the nasal cavity is aseptic (St Clair Thomson) With the ear, however, things are very different, the meatus should be well syringed with carbolic lotion (1 in 20), and lightly packed with some efficient dressing, a large pad of the same being bandaged over the affected side of the head This must be replaced as often as necessary Beyond this, the treatment of fractured base is directed to the cerebral condition, and does not differ from that usually applied to head injuries, viz, cold to the shaved head (preferably by means of Leiter's tubes), a smart calomel purge to start with, low diet, and absolute quiet in a dark room The patient should be kept from going about his work for at least six weeks

3. **Depressed and Punctured Fractures** usually involve the vault of the cranium, and are due to direct violence, either from a fall or blow, causing a simple or compound fracture, or from a penetrating injury occasioning a punctured fracture In both cases there is often a considerable amount of comminution

It is quite possible for the outer table to be broken and depressed, without any injury to the inner, where an air cavity exists in the bone, or if the diploe is very thick, thus, the bone may be driven in over the frontal sinus without injury to its inner wall, or the mastoid may be similarly affected The inner table has also been broken, and fragments even separated, as a result of a simple depression without fracture of the outer table, this rarely occurs in adults, but

is not uncommon in children. Amongst the latter, it is also possible for a considerable depression to exist without any fracture even of the inner table.

More usually both inner and outer tables are involved, and when such is due to force reaching it from without, the inner table is always more damaged than the outer, especially in the punctured variety (Fig 273, A and B). When, however, the force is applied from within, as by a bullet which has traversed the brain, the outer table suffers more than the inner. The causes of this condition are similar, from whichever side the force comes, we shall, however, only discuss the case of a wound coming from without.

(a) The inner table is less supported than the outer, having merely the soft brain and dura mater within, and hence is extensively splintered, just as a nail driven through an unsupported piece of wood causes ripping up of its under surface.

(b) The loss of momentum of the fracturing body will assist this, the greater the momentum of a bullet, the more cleanly it cuts, a smaller momentum breaking or splintering rather than cutting, of course, a considerable amount of force is expended in penetrating the outer table.

(c) The debris caused by the injury to the outer table will add to the bulk of the

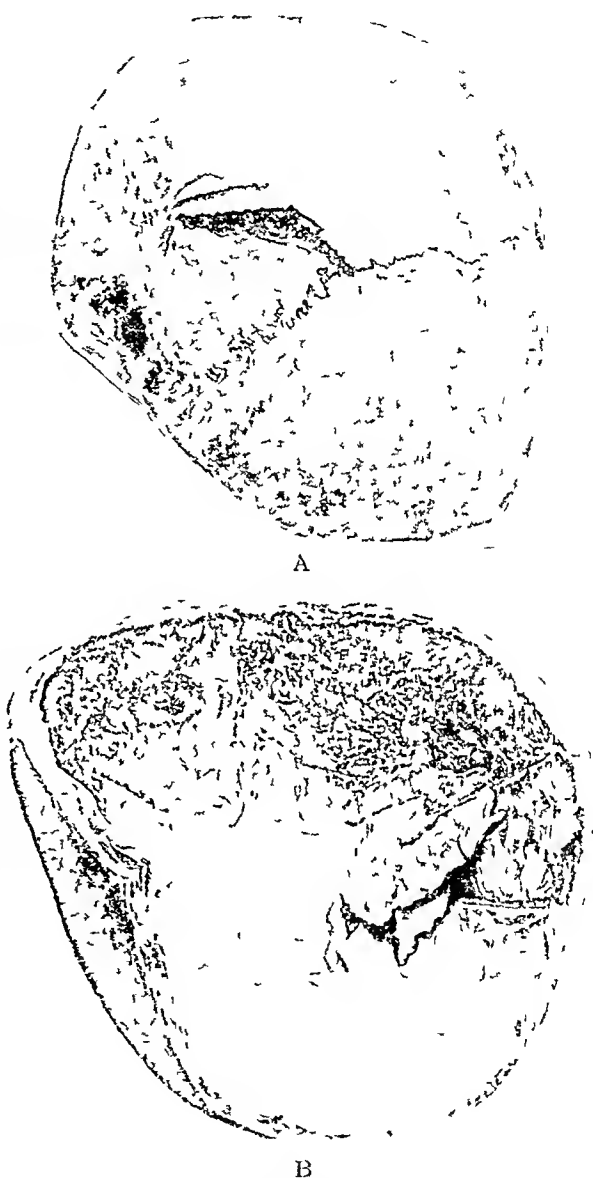


FIG 273 —DEPRESSED FRACTURE OF SKULL SEEN FROM WITHOUT AND FROM WITHIN (KING'S COLLEGE HOSPITAL MUSEUM)

penetrating body, and its wedge-like action still further increases the injury to the inner table (*d*) All force tends to radiate and diffuse itself from the spot struck, and hence, if the outer table is first injured, the force will be disseminated over a much wider area of the inner

The **Symptoms and Signs** arising from a depressed fracture vary widely in their nature, and are partly due to the injury inflicted on the bone, partly to that sustained by the brain, whilst the septicity or not of the wound is of the gravest significance

*Locally*, when an external wound is present, one sees blood or cerebro spinal fluid escaping, or even brain-substance protruding. The damage to the bone may be seen or felt, and the extent of the depression or comminution ascertained. When there is no external wound, a hæmatoma of variable size forms under the scalp, more or less obscuring the fracture. The character of the lesion is a matter of considerable importance from a prognostic point of view. When the bone shelves evenly in all directions, a *pond* or *saucer* fracture is said to be present, and such is tolerably amenable to treatment, when, however, the depression is sudden and complete, the detached portion lying below the level of the rest of the bone, it is termed a *gutter* fracture, and the prognosis is increasingly grave. The two forms are, however, often associated. Necessarily, considerable variations are met with in this type of fracture, according to the nature of the injury and the means by which it was inflicted. Thus, if it is due to a fall on the vertex, there is often a ragged, irregular scalp wound, through which the depression can be seen or felt, if caused by the puncture of a sharp tool, such as a pickaxe, there is only a small external opening corresponding to the hole in the skull, in which the point of the instrument may be found embedded. A slicing cut with a sabre or hatchet produces a clean incision through the scalp, together with a linear groove in the skull, perhaps somewhat bevelled, which may or may not penetrate its whole thickness. Sometimes detached portions of the skull are raised above their ordinary level, constituting an *elevated* fracture, it is usually associated with depression of surrounding parts.

*Gunshot injuries* of the skull manifest any degree of severity, according to the velocity and angle of incidence of the projectile. A non-penetrating wound produces either a severe localized contusion or a depression with or without comminution. If a modern conical bullet, travelling at a high rate of speed, strikes the skull, it will probably penetrate, and possibly may traverse both sides and thus escape, doing comparatively little harm, except along its immediate track. If, however, the bullet is of an expanding type, or if it is travelling slowly, it may cause a much more serious lesion.

In a *simple depressed fracture* the patient usually suffers from concussion, followed almost immediately by compression, the latter due in part to the depressed bone, but mainly to exudation of blood and bruising of the brain, and if this is at all extensive and remains unrelieved, a fatal result quickly follows. Where, however, the

depression is but slight, the symptoms of compression may be absent or not marked, and the patient recovers, perhaps to become the subject of traumatic epilepsy or insanity at a later date, induced by the irritation of the dura mater and of the subjacent cortex. If the depressed fragments irritate the motor area, convulsions, spasms, or paralysis may be thereby induced.

In a *compound depressed or punctured fracture* the immediate effects are not necessarily severe, the patient perhaps not even suffering from concussion, though brain substance presents in the wound, the more limited the spot injured, the less the concussion. The explanation of this fact is that the blow has expended its force in fracturing the cranium, and hence does little harm to the brain, in the same way that a watch may receive but slight damage from a fall if the glass is broken, whilst if the latter remains intact the works are liable to suffer.

Left to itself, such a fracture is sure to become *septic*, and inflammation of the bone, brain, or membranes will follow.

Septic osteitis leads to necrosis of the fragments, which may be seen lying dead and yellow at the bottom of the wound, whilst the inflammation may either spread along the diploe to the surrounding bone, causing extensive necrosis with pyæmia, or between the bone and the dura mater, leading to a subcranial abscess.

When once the dura mater has been penetrated, inflammation is liable to spread to the meninges, and then a diffuse or localized suppurative meningitis, accompanied or not with a localized suppuration of the brain, will ensue. Even if the dura mater has not been opened by the injury, the irritation of depressed spicules of bone and the presence of a septic exudation often lead to its ulceration at a later date. If there is a free external opening, allowing a ready exit to the discharge, and thus preventing tension, the process may be quite limited, and compression of the brain or diffuse septic meningitis is avoided, but if the bones are locked together as well as depressed, and the external wound is small, retention of inflammatory products may lead to their diffusion, and the symptoms of compression will soon become evident. A hernia cerebri may also form subsequently.

When the fragments of depressed bone are early removed, even if perfect asepsis is not attained, the patient has a good chance of recovery, whilst laceration of the dura need not result in meningitis, since the opening in the subdural space can be shut off by adhesions of the arachnoid in a very short time.

When an *aseptic* condition of the wound is obtained by early interference, and depressed fragments of bone are successfully elevated or removed, the prognosis becomes much better, and the case may run an uncomplicated course towards recovery, unless some deeper cerebral lesion co-exists.

The **Treatment** of these cases has been much changed by the introduction of antiseptics, the opinion now prevalent being that a patient runs greater risks from leaving a slight depression unrelieved than by making even what may prove to be an unnecessary exploration. The object of the operation in all cases is to elevate depressed bone and



to remove sharp edges of fragments, which might injure the dura mater. We may epitomize the treatment thus

- (1) In all punctured fractures, operate
- (ii) In all compound depressed fractures, operate
- (iii) In simple depressed fractures. In adults, always operate, in children, if gutter-shaped, operate, if pond-shaped, wait for symptoms, unless the fracture is a bad one

The most debatable of these propositions is that relating to the simple depressed fracture in an adult. It may be objected that many such cases have recovered without operation, and that therefore in shallow depressions one should wait for symptoms, but, whilst admitting the fact, we recall cases where the neglect of such treatment has led to serious trouble, and we have been called on not unfrequently to trephine for traumatic epilepsy due to this very type of injury. The operation is so slight, and the risk so insignificant

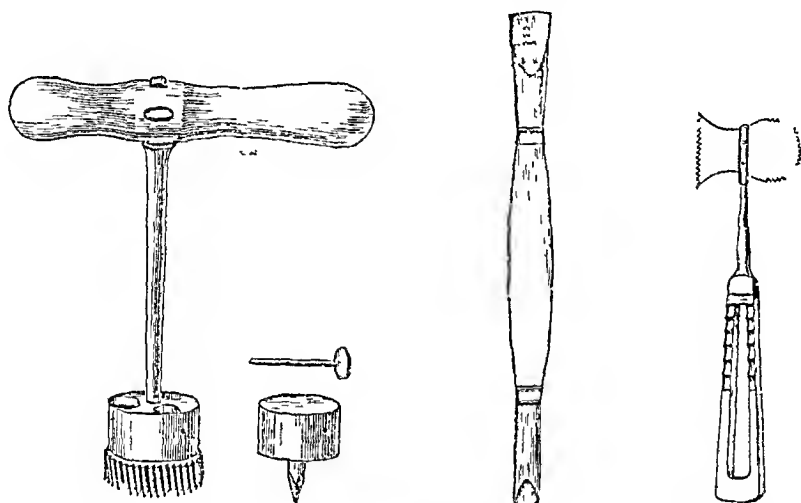


FIG 274 — INSTRUMENTS USED IN TREPHINING FOR OR ELEVATING A DEPRESSED FRACTURE, INCLUDING TREPHINE, ELEVATOR, AND HEY'S SAW (DOWN BROTHERS)

when asepsis is maintained, that the patient should be given the benefit of an exploration, especially since one can never be certain of the amount of injury sustained by the inner table.

When an operation has once been decided on, the sooner it is undertaken the better. The scalp should be shaved and thoroughly purified. An anæsthetic may or may not be given, according to the condition of the patient. In a *simple depressed fracture* the surgeon should never incise the skin directly over the wound, but should turn down a flap to avoid the presence of a cicatrix over the lesion in the bone. Having cleared away blood-clot and exposed the fracture, some loose fragments may present, and the removal of these may permit of the introduction of an elevator, if more room is required, Hoffmann's bone rongeur will suffice to enlarge the opening

If there are no loose fragments, it is sometimes possible to make an opening by sawing off a corner of bone with a Hey's saw. If neither of these plans is feasible, an opening must be made with a trephine. The centre-pin is placed upon some firm undepressed bone as near the margin as possible (Fig 275), and a circle of bone removed. An elevator can now be introduced, the fragments prised up into position, and the condition of the inner table investigated. Care must be taken in removing loose fragments not to tear the dura mater by injudicious violence, especially is this the case when the fracture lies over one of the venous sinuses. Sufficient bone must be taken away to allow the whole of the damaged area to be examined. The bony tissue taken away during the operation should be kept in warm boracic lotion or saline solution, or may be tucked in under the flap and thereby protected. When the loss of substance is small, there is no need to replace the fragments, but when it is of considerable size, it is wise to attempt this, wedging them accurately together, so that none lie loose in the wound. An opening for drainage may be left between them, if need be. In other cases they may be chipped up into small pieces and powdered over the wound.

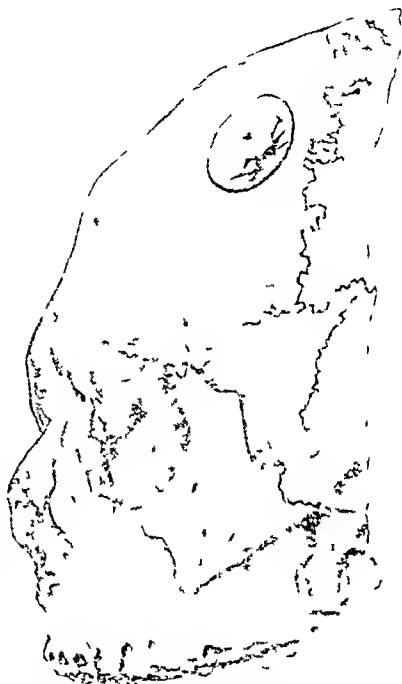


FIG 275 —PUNCTURED FRACTURE OF SKULL SHOWING SPOT FOR APPLICATION OF TREPHINE

If the dura mater has been injured, brain substance mixed with blood may escape as soon as the flap is raised. When the bone has been dealt with, any protruding portion of cerebral material is removed, and the dura mater lightly stitched across the gap. The fragments of bone are then replaced as indicated above, with a small opening for drainage between them. If the dura mater cannot be closed, an attempt must be made to prevent the formation of adhesions between the brain substance and the superjacent tissues—such a fertile source of traumatic epilepsy. This is best effected by introducing a piece of sterile gold-foil (or some similar substance) between the brain and the dura mater.

In a *compound depressed fracture* the conditions vary so much that it is difficult to give precise indications for treatment. As a general rule, however, the scalp is first shaved and purified, a flap is then turned up so as to expose the bony lesion. Loose fragments of bone are removed, and depressed portions elevated in the usual way. It

is generally unwise to replace bone in these cases, as they are probably infected, and any attempt to purify them by antiseptics would be likely to destroy their vitality. The margins of the defect are carefully cleansed, and sterile decalcified bone-chips may be sown over the surface of the dura mater. The scalp flap is replaced, and, if possible, the original wound sutured after trimming up or excising its edges. An opening for drainage may be made through the lower part of the flap.

Exposed or protuberant brain substance is dealt with as in simple fractures, except that it is necessary to purify it by washing with some efficient antiseptic, such as 5 per cent carbolic lotion, or a 1 in 2,000 sublimate solution, of course, drainage is essential in these cases, but the drainage tube should be removed, if possible, in forty-eight hours, so as to minimize the chances of hernia cerebri.

In a *punctured fracture*, although the opening in the bone may be small, a large circle is removed, since the inner table is almost always extensively damaged. The centre-pin should rest on sound bone, as near the opening as possible (Fig 275), and care must be taken to include all depressed fissures in the field of operation. If need be, the dura mater must be opened up and the brain explored.

In all cases the patient should be confined to bed with the head low, and the general rules suitable to head injuries followed. It is by no means certain that elevation of the depressed bone will relieve the symptoms, as they may be due to hæmorrhagic effusion into the brain which cannot be reached.

For treatment of gunshot injuries of the skull, see pp 241 and 776.

The symptoms and treatment of the intracranial complications of head injuries are dealt with in the next chapter.

### Affections of the Frontal Sinuses

These sinuses are cavities in the frontal bones lined with a mucous membrane continuous with that of the nose. They can hardly be said to exist in children, not developing much before the age of puberty. In adults they vary much in size and shape, and are often very asymmetrical, the prominence of the superciliary ridges is no guide to their extent.

Fracture of the anterior wall is not uncommon as the result of a direct blow, depression of the fragments being produced, but without cerebral complications. If the mucous membrane is torn, surgical emphysema of the scalp and face may follow, and is naturally increased on blowing the nose. In compound fractures, suppuration usually occurs, leading to septic osteitis and necrosis of the frontal bone, and, if the posterior wall is involved, to a subcranial or even a cerebral abscess. In rare cases, when the anterior wall has been destroyed, a localized collection of air may form under the skin, and remain as a permanent tumour, constituting what is known as a *pneumatocele capitis*, it rises and falls with forced respirations. A similar condition may also result from a fracture into the mastoid

cells, in either situation it should be treated by compression, or, failing this, incision

**Inflammation** of the frontal sinus is caused by extension of catarrh from the nose, by penetrating wounds or fractures, by foreign bodies, or it may be secondary to disease of neighbouring bones

**Acute Inflammation** is usually of a catarrhal type, and produces frontal headache, tenderness and pain on pressure both above and below the eyebrow, and a feeling of dulness or apathy Constitutional conditions, pyrexia, etc., may also be present In such cases the forehead should be constantly fomented, and the patient inhales steam from hot water to which eucalyptus and menthol have been added, rest in bed and suitable purgatives are also necessary

**Acute Suppuration** of the sinus is generally traumatic, and then is liable to extend into the frontal bone, giving rise to an acute osteo-myelitis, which may spread rapidly The posterior wall of the sinuses is extremely thin, so that the membranes of the brain are easily invaded, and an abscess may develop in the frontal lobe Occasionally extension of mischief to the cavernous or other venous sinuses may follow

The case must be treated by laying the cavity open and draining it For this purpose a curved incision is made along or immediately below the eyebrow, and the soft parts stripped from the bone, through which a sufficient opening is made with a gouge close to the middle line, the pus or mucus is removed, the interior very gently curetted, and the passage into the nose explored and dilated so as to allow of free drainage The cavity is syringed out for some days, and the wound usually closes readily, although a fistula occasionally remains A median vertical incision is useful if there is any doubt as to which sinus is involved, or if both are affected

Should acute osteo-myelitis develop, vigorous measures are necessary In a case of this type recently under treatment, incisions were made along each eyebrow from the middle line, and a vertical one extending from the hair to the root of the nose The flaps thus formed were thrown back, the sinuses freely opened, and their anterior walls entirely removed a large amount of the frontal bone was also taken away until healthy diploe free from purulent infiltration was reached During the process the posterior wall of the right sinus was removed, and a large cerebral abscess opened The patient made a good recovery, although a considerable amount of dead bone had to be subsequently taken away

**Chronic Empyema** of the frontal sinus may be the outcome of an acute catarrhal inflammation or may be chronic from the first, extending upwards from the nose Pus is constantly found in the anterior portion of the middle meatus, and its discharge is not much influenced by the position of the head Frontal headache is often complained of, and there may be some localized tenderness on pressure. If the infundibulum becomes blocked, the pus may collect and lead to distension of the cavity, the bony walls gradually yielding and thinning before the pressure A similar condition occasionally results

from distension of the cavity with mucus (*hydrops*) When the walls are sufficiently thinned, eggshell-crackling may be noticed

In the **Treatment** of chronic empyema external operation must, if possible, be avoided, since experience has shown that it is associated with a definite mortality, due to acute osteomyelitis The intranasal condition is carefully treated, the anterior portion of the middle turbinal is removed so as to give a better exit to the discharge, and a skilled rhinologist may be able to pass a tube up the infundibulum and wash out the cavity Should these measures fail to give relief, and should urgent symptoms appear, then the cavity must be opened as described above, and a tube passed through into the nose, the external wound either being closed at once (Luc), or left open for a few days and packed with gauze.

The chief **Tumours** growing from the frontal sinuses are mucous cysts or polypi and ivory osteomata, they may also be involved in diffuse sarcoma or carcinoma, but the disease is then not limited to the sinus The main symptoms and signs result from distension of the walls of the cavity, which may yield anteriorly, causing a large frontal swelling, or the posterior wall is absorbed, leading to cerebral compression, or the upper wall of the orbit may be depressed, causing dislocation of the eyeball, and possibly blindness (Fig 44, p 195) Tumours which have attained considerable dimensions can rarely be removed, death then resulting from cerebral compression, but occasionally bony masses may necrose, and become loosened by suppuration around them, and in a few cases they have been taken away successfully

## CHAPTER XXVI

### AFFECTIONS OF THE BRAIN AND ITS MEMBRANES

#### Cranio-Cerebral Topography

It is scarcely necessary or desirable in a students' manual to deal exhaustively with this subject. The main facts can alone be referred to, and larger text-books of operative surgery or surgical anatomy referred to for further details.

The *Fissure of Rolando* may be found topographically by the following methods. (a) The upper extremity of the fissure corresponds to a point 1 centimetre (or  $\frac{2}{5}$  inch) behind the centre of the line extending from the fronto nasal suture to the external occipital protuberance. The direction of the sulcus is downwards and forwards at an angle of about  $67^\circ$  to the middle line. This may be indicated by laying a half-sheet of letter-paper over the skull, the long side corresponding to the middle line, and with its centre over the upper limit of the fissure, the anterior half is now folded over obliquely from this point, leaving an angle of  $45^\circ$  between the front of the paper and the middle line of the skull, and then the same process is again repeated, bisecting the angle and leaving one of about  $67^\circ$ , so that the anterior limit of the folded paper corresponds to the line of the fissure, which is about  $3\frac{1}{8}$  inches in length. A 'Rolandometer,' consisting of two strips of flexible metal united at the appropriate angle, is now sold by many instrument makers. As a general rule this 'Rolandic line' will cross the fissure about its centre, being in front of the fissure above and a little behind it below, but it is sufficiently accurate for practical purposes. (b) A less exact method is that defined by Dr Reid, the measurements for which are all worked from the so-called Reid's base-line, which is one drawn on the skull from the lower margin of the orbit backwards through the centre of the external auditory meatus, reaching the middle line behind just below the occipital protuberance (Fig 276). From it are drawn upwards two perpendiculars, one (C D) corresponding to the small depression in front of the external auditory meatus, the other (E F) to the posterior border of the mastoid process. The fissure of Rolando

\* For a recent review of the relative accuracy of various methods, see a paper by Berry and Shepherd *Brit Med Journ* p 1382 November 19 1904

extends from the upper limit of the posterior vertical line to the point where the anterior line intersects the fissure of Sylvius

To map out the *Fissure of Sylvius*, (1) Reid utilizes a line drawn from a point  $1\frac{1}{4}$  inches directly behind the external angular process of the frontal bone (Fig 276, A), and about the same distance above

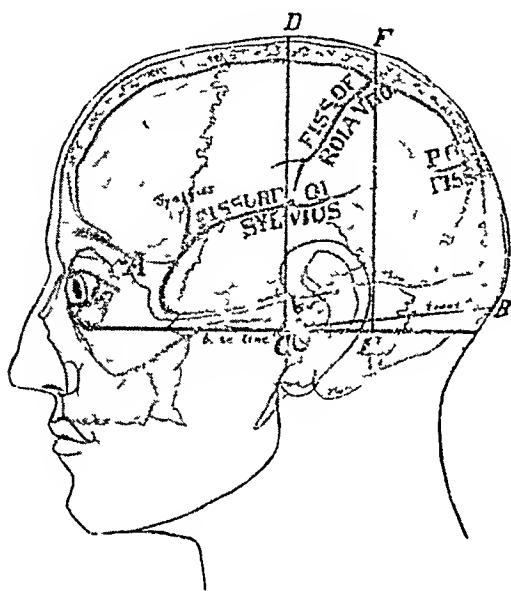


FIG 276 —DIAGRAM OF HEAD TO INDICATE METHOD OF FINDING THE FISSURES OF ROLANDO AND SYLVIVUS BY REID'S METHOD (AFTER REID)

*Sy a fiss*, Anterior branch of Sylvian fissure, *P O Fiss*, parieto occipital fissure *trans fiss*, transverse fissure along line of tentorium A external angular process of frontal bone B, occipital protuberance, C D, anterior perpendicular in front of tragus E F posterior perpendicular through back of mastoid process

the zygoma, to a spot  $\frac{1}{2}$  inch below the most prominent part of the parietal eminence The undivided portion of the fissure is represented by the first  $\frac{1}{4}$  inch, and from here the anterior limb (*Sy a fiss*) rises vertically upwards for about an inch, whilst the posterior limb extends backwards for the rest of the line If prolonged to the middle line behind, it indicates with tolerable accuracy the situation of the parieto-occipital fissure (*P O Fiss*) Careful investigation, however, has shown that no great reliability can be placed on this method

(2) Hare and Thane suggest the following measurements, which in the majority of adult skulls may be looked on as substantially accurate To find the *Sylvian point* (i.e., the point of bifurcation of the suture), a line is drawn horizontally backwards

from the fronto-malar suture for a distance of 35 millimetres, and from the posterior end of this a vertical line upwards for 12 millimetres, the upper extremity of this line is the Sylvian point The posterior limb of the Sylvian fissure is indicated by a line drawn backwards from the fronto-malar suture through the Sylvian point to the lower part of the parietal eminence

The external limb of the *parieto-occipital fissure* corresponds almost exactly to the lambda

Professor Chiene of Edinburgh has devised an ingenious and complicated method of topography, but recent investigations indicate that, although it is satisfactory for the Sylvian point and fissure, it is not always to be relied on in other directions, and the plans above

indicated are quite sufficient for practical purposes. After all, when it is a matter of operation, surgeons do not limit themselves to a small trephine opening, but remove considerable portions of the cranium.

### Methods of Opening the Cranium

In the old days but one instrument was employed for this purpose, viz., the trephine, but our increasing knowledge of cerebral lesions and the security given by aseptic methods have necessitated a considerable elaboration in the methods of operating on the cranium.

1 Simple *trephining* is still employed in dealing with many traumatic lesions where an extensive exposure of the brain is not required. The modern trephine (Fig. 274) is usually fitted with a solid metal handle to render sterilization easy, and the crown is usually bevelled and not straight, so as to check the liability to slip inwards and wound the dura. The scalp is incised and turned aside, usually by raising a flap which has its base downwards, so as to ensure its vitality. The pericranium is stripped from the bone, and the trephine applied with the centre-pin projecting. As soon as a well-marked groove has been made, the centre pin is withdrawn or removed, and the instrument carried through the cranium. An increased flow of blood will often indicate when the diploe is reached, and care must be taken not to injure the dura. To this end the groove in the bone is carefully examined from time to time by a flattened probe or the blunt end of a needle, and the more so when the operation is undertaken in a region where the bone is known to be of irregular thickness. The disc is removed by an elevator (Fig. 274). Considerable bleeding sometimes takes place from the section of the bone, but can usually be controlled by crushing the spot with powerful forceps, or by rubbing in Horsley's wax (carbolic acid, 1 part, oil, 2 parts, wax, 7 parts). If the opening is not sufficiently large, it may be increased by the bone rongeur, Hey's saw or cutting pliers, or even by the trephine.

2 In many cases of cerebral abscess the trephine is unnecessary, as the causative focus (e.g., mastoid disease or frontal sinus empyema) is opened up, and the cranial cavity can then be reached by removing the deeper portions of bone with a gouge. When well inside the skull, a bone rongeur or de Vilbiss' punch will suffice to enlarge the opening. Even when the cranium is intact, the gouge is used by some in preference to the trephine to make the first opening.

3 When a considerable area of the brain needs exposure, as in the case of cerebral tumours, various plans are adopted.

(a) Some surgeons utilize a large 2 inch trephine, but this is obviously undesirable owing to the irregular thickness of the skull, and the difficulty which necessarily attends the equal deepening of the groove in all directions over such a large circumference.

(b) When there is no likelihood of being able to replace the bones, a small trephine hole and enlargement by the rongeur may be relied on.



(c) Of late, however, some form of Wagner's osteoplastic method has been chiefly used. In this a flap of scalp tissues is turned down together with the underlying bone, laying bare the dura mater. Some surgeons divide the bone along the line of incision with a chisel and mallet, this is not to be recommended, as the dangers of serious concussion of the brain from such a plan are not to be overlooked. Others use a circular saw, but probably the simplest way is to make four small trephine openings at the corners of the flap, and connect these either by the use of a Hey's saw, or by a Gigli saw (*i.e.*, a piano-wire with a screw-thread turned on it, and with handles attached at each end), passed by means of a probe under the bone from one opening to another, or by the use of a rongeur on two sides, whilst the upper end is sawn through by a Hey's saw set on the slant, so that the incision is bevelled, thereby preventing the bone from slipping in when replaced, and the base is divided by a Gigli saw.

This osteoplastic procedure is a serious one, attended by considerable shock and hæmorrhage, and therefore is often undertaken as a preliminary measure a week or ten days before the lesion in the brain is dealt with.

### Lumbar Puncture in the Diagnosis of Cerebral Lesions

It is a very easy matter to withdraw a quantity of the cerebro-spinal fluid for examination by lumbar puncture. A stout antitoxin or exploring needle should be selected and sterilized by boiling, and the skin in the region of the third and fourth interspaces in the lumbar spine (the spinous process of the fourth vertebra is on a line joining the iliac crests) is to be carefully sterilized as if for a major operation. The point of the needle is then inserted in the middle of the fourth interspace and about a third of an inch from the middle line, it must be pointed forwards, with a very slight inclination inwards and upwards. In most cases it will go straight into the spinal canal below the termination of the cord, and the fluid will escape. If bone is encountered, it is advisable to withdraw the needle completely and re-insert it at a slightly different angle. In cases of repeated failure the third interspace may be tried.

Normal cerebro-spinal fluid is as clear as water, contains a trace of albumen and of a copper-reducing substance, but practically no cells. It escapes drop by drop.

In *acute meningitis*, due to organisms other than the tubercle bacillus, the fluid is turbid and contains much albumen. There are numerous cells present, most of which are polynuclear leucocytes. Bacteria may be detected by suitable methods of staining or by cultures.

In *tuberculous meningitis* the fluid is almost clear, and contains a slight excess of albumen and of cells, the latter are almost all lymphocytes. Tubercle bacilli may be found, but a careful search is necessary. In all varieties of meningitis the fluid is secreted under excessive pressure, and usually issues from the needle in a stream.

In *cerebral abscess* the fluid is normal, but may be under excessive pressure. Lumbar puncture is a most important adjunct in the diagnosis of the intracranial complications of middle-ear disease.

In *fracture of the base of the brain* or of the *spinal column*, blood usually appears in the cerebro-spinal fluid within a few hours of the injury. A small amount of blood from the tissues through which the needle has passed may occur in the first few drops of fluid under any circumstances, and should be discounted, in hæmorrhage the blood is intimately mixed with the fluid.

### General Conditions of the Brain after Head Injuries

*Concussion of the Brain*, or stunning, is a clinical condition, a more or less complete suspension of its functions as a result of an injury to the head, which results in some commotion of the cerebral substance, and may or may not be associated with hæmorrhage. It varies with the severity of the cause from a slight momentary giddiness and confusion of thought to the most complete insensibility, and is closely allied to shock, from which it is often distinguished with difficulty.

In fatal cases, one finds on post-mortem examination merely the same conditions as obtain in shock, viz, engorgement of the lungs, viscera, and the right side of the heart, whilst the brain presents some lesion of varying severity, from mere punctiform ecchymoses to actual disintegration and disorganization. The symptoms are supposed to be due to a paralysis of the vasomotor centres in the medulla and subsequent loss of vascular tone, allowing the blood to gravitate to the most distensible parts, viz, the portal system. Reflex inhibition of the heart through the vagus may also assist in their production. More recently Duret has suggested that the blow on the skull causes a temporary localized depression of the bone, and this leads to compression of a cone shaped area of the brain substance. As a result, the cerebro spinal fluid is displaced and forced downwards to the base of the skull, where it tends to collect, particularly in the fourth ventricle, and thus the vital centres grouped around this space are compressed. This explanation of concussion is very feasible.

The **Symptoms** vary considerably in degree, but in a well-marked case the stage of concussion is evidenced by unconsciousness, more or less complete, although the patient can sometimes be roused by shouting, he lies on his back, with the muscles relaxed and flaccid, the eyelids are closed, and the conjunctivæ may be insensitve, the pupils vary, but are equal and often contracted, usually reacting to light, but in bad cases they are dilated, and do not contract when light is admitted. The surface of the body is pale, cold, and clammy, and in severe cases insensitve even to strong electric shocks. The respirations are slow, shallow, and sighing, whilst the pulse is weak, fluttering, and scarcely sensible to the fingers, the temperature is subnormal, the sphincters are relaxed, with perhaps unconscious evacuations from both bladder and bowel. The reflexes are present

in the milder cases, though sluggish, in the more severe they may be entirely absent

This condition may last for a considerable time, and then pass slowly into more profound unconsciousness and death, or be followed by the phenomena of inflammation, compression, or cerebral irritation. If, however, the case is going on to recovery, *reaction* soon begins to manifest itself. The patient is presumably put to bed, and warmth carefully applied to the extremities. The first sign of reaction is probably a slightly increased rate of both breathing and pulse, whilst he may be able to tell his name and address, sometimes the earliest indication of recovery is that he turns on his side, and pulls the bed-clothes up to his face, since he feels cold and chilly as a result of the cutaneous anæmia. Gradually he becomes more and more rational, and the functions of both mind and body are restored, reaction being fully established by the occurrence of vomiting, due to a condition of cerebral hyperæmia following the anæmia. Probably he suffers from headache for some days, and a slight amount of fever will follow, but this passes off, and leaves the patient either quite well, or with a somewhat irritable brain requiring prolonged rest. Subsequent events may, however, prove that more mischief has been done than appears at first. One sequela of concussion may be that some special function of the brain is permanently lost or impaired, such as memory, hearing, or vision, thus, a patient may forget the names of places or persons, or may lose all memory of time, speech may become defective or stammering, or a certain amount of asthenopia (weakness of vision) may supervene. Such individuals are very liable to recurrent attacks of inflammation, one of which may prove fatal. Others are left with an inordinately irritable brain, incapable of standing excess of work or errors of diet, and in such a sudden fatal issue is not uncommon. Others, again, seem to suffer from a general loss of nerve tone (neurasthenia), rendering them incapable of fulfilling their ordinary duties in life.

The **Treatment** of concussion very closely resembles that of shock, viz, the patient is at once put to bed, with the head low, and is covered with warm blankets, hot-water bottles may be applied to the extremities, and friction to the surface. Any needless stimulation must be avoided for fear of exciting hæmorrhage, an enema of hot coffee may be given, or, if *in extremis*, brandy, or a hypodermic injection of strychnine. A good purge, such as 5 grains of calomel, or a drop or two of croton oil on sugar, should be administered after reaction in the milder cases, but whilst still unconscious in the graver forms, and the patient is then kept for some days in bed on a restricted diet, with the bowels freely open and all sources of excitement excluded.

When the unconsciousness is prolonged, and the absence of signs of fracture of the cranium or of focal symptoms prevents the localizing of the lesion, the head should be shaved, and an icebag or Leiter's tubes applied, the bowels are kept acting freely, and the state of the bladder attended to, the room must be kept dark and quiet, the attendants making as little noise in walking and talking, etc., as

possible, sufficient nourishment must be given either by a spoon if the patient can thus take it, or by nutrient enemata or a nasal tube

**Cerebral Irritation** — By cerebral irritation is meant a clinical condition which sometimes follows concussion, characterized by great irritability of both mind and body. It usually results from blows or falls on the temple, forehead, or occiput, and is probably due to a superficial laceration of the brain, possibly in the frontal region, and to the hyperæmia caused by its subsequent repair

The **Symptoms** are very characteristic, and usually manifest themselves two or three days after the injury. They may be divided into two groups — (a) *Bodily Symptoms*. The patient lies on his side in a condition of general flexion, the back arched, the legs drawn up to his abdomen with the knees bent, and the hands and arms drawn in. He is restless, and may toss about, but never fully extends himself or lies supine. The eyes are closely shut, and he resists all attempts to open them, the pupils are contracted, the temperature is usually a little raised, but the surface of the body and head are both cool, the pulse is quiet but weak, the sphincters are usually in a normal condition, and the excreta are often passed in the bed, but the bladder may occasionally need to be emptied by catheter. In some mild instances the patient may get up to empty his bladder and then return to bed. (b) *Mental Condition*. The patient is by no means unconscious, but he takes no heed of what is passing around, and is intensely and morbidly irritable. When disturbed, he will gnash his teeth, frown, swear, and resent the intrusion in the most expressive manner. At the end of a few days, or perhaps after a week or two, a marked alteration in the condition of the patient usually shows itself. He is less irritable, begins to stretch himself out, and with this is conjoined an improvement in both pulse and temperature. A change is sometimes noticed in his mental state, since he may be quite childish and weak. 'Irritability gives way to fatuity' (Erichsen). In this stage he may need to be treated as a child, and even taught the names of persons and things, later on he may glibly detail the history and cause of his accident, giving a fresh story every day, but frequently there is an absolute lapse of memory concerning the accident and the events which led to it. After a time the brain recovers, but more or less serious after-effects are likely to ensue. Sometimes the symptoms pass over, however, into those of subacute or chronic meningitis.

In the **Treatment** the surgeon must remember that there is a considerable tendency to asthenia, and hence, while the patient is kept quiet and free from all noise or excitement, he must be well supported by a light and nourishing diet. The head should be placed low and shaved, and Leiter's tubes fitted on, if the patient will permit it, but it is better to omit this entirely than to apply cold intermittently. The bowels must be kept well open, and possibly small doses of bromides, or even opium, may be useful. If any signs of meningeal inflammation follow, such as rise of temperature and pulse, heat of head, and great sleeplessness, blisters or leeches may be applied locally, and mercury administered internally.

**Compression of the Brain**—Compression is the term given to a clinical condition due to some abnormal and excessive intra-cranial pressure which disturbs the functions of the brain. In the earlier stages a displacement of cerebro-spinal fluid from the cranium to the vertebral canal may relieve the symptoms, but as the pressure increases, the brain substance itself suffers, the cortical centres being involved first, and the medulla last. When of traumatic origin, it may arise from the following causes: (a) Depressed bone or the presence of a foreign body, in which case the symptoms of concussion merge directly into those of compression, and usually without any interval of consciousness. It is probable, however, that in these cases the symptoms are due more to the associated hæmorrhage or inflammation than to the actual cranial lesion. (b) Extravasation of blood within the cranium, either outside the membranes, or on the surface of the brain, or within its substance. If the bleeding is extradural, there will probably be a short interval of consciousness between the concussion and the compression, if the bleeding is cerebral, the symptoms of compression may manifest themselves at once without any interval being noticed. (c) It may be due to an acute spreading œdema, the explanation of which is subsequently given (p. 771). (d) It may arise from a collection of inflammatory exudation or pus, in which case the symptoms are preceded by those of inflammation, and at the earliest will not manifest themselves before the third day, whilst they may be deferred for a week or two.

Compression may also arise as a result of idiopathic hæmorrhage, tumours, gummata, or abscesses, *e.g.*, as a complication of middle-ear disease.

The **Symptoms** of compression are essentially those of *coma*. When the condition is well established, the patient lies on his back absolutely unconscious, and cannot be roused either by shouting or shaking. His breathing is slow, laboured, and stertorous, the lips and cheeks being puffed in and out. The stertor arises from paralysis of the soft palate, and the puffing of the cheeks from paralysis of the facial muscles. In the later stages the respirations may be more rapid and irregular, somewhat approaching the Cheyne-Stokes type. Death arises from cessation of the respiratory act. The pulse is full and slow at first from irritation of the vagus and vasomotor centres, but later on becomes rapid and irregular, owing to increased pressure upon and exhaustion of these medullary centres. The surface of the body may either be cool, hot, or perspiring, the body temperature similarly varies, in some cases being hyperpyrexial, in others low, and where the compressing force is unilateral, there may be some difference on the two sides of the body. The pupils become dilated without responding to light, but vary according to the degree of compression and the situation of the compressing agent. If the cerebral pressure is equally diffused, both pupils first contract, and then gradually dilate and become reactionless, but if one hemisphere is affected more than the other, the pupil on that side passes rapidly through these changes, whilst on the opposite side they are not developed.

until later. Thus, it is a common thing to find the pupils unequal in size, and reacting differently to light. The whole body in the later stages is in a condition of *motor paralysis*, but at an earlier period of the case there may be some difference on the two sides, if the lesion is unilateral, thus, if the left side of the brain is primarily affected, a right-sided hemiplegia is likely to be present at a time when the muscles on the left side can still respond to cerebral stimuli. A localized compression involving the motor area may lead to convulsions in the corresponding group of muscles. The bladder is paralyzed, and hence retention ensues, whilst the sphincter ani is relaxed, and fæces pass involuntarily, although marked constipation is usually present.

The symptoms in some cases are ushered in by severe pain or headache, which is partly due to pressure upon and tearing of the dura mater, and partly to the altered vascular conditions of the brain, the brain substance itself is not sensitive, and hence the pain is not directly referable to any lesion of or pressure upon it. Naturally, the clinical picture is modified according to the cause of the compression, and it is impossible to discuss here more than the general features. The course of the case, too, varies widely according to whether or not the compressing agent can be removed by the surgeon, or absorbed by natural processes. Patients not uncommonly recover from small cerebral and intrameningeal hæmorrhages causing temporary compression, but rarely do so without operation if the symptoms are due to depressed bone, the presence of a foreign body, or large exudations of blood, serum, or pus.

The **Diagnosis** of coma from compression, when a complete history of the case can be obtained, is often easy, and, indeed, the whole clinical aspect may be so typical that no question as to the cause of unconsciousness can be raised. But when a person is found in the streets unconscious, and no history either of the patient or of an accident is obtainable, and no serious lesion of the skull is present, the diagnosis is often extremely obscure, since coma may be due to many other causes, *e.g.* (a) Cerebral lesions, such as apoplexy, whether the result of hæmorrhage, embolus, or thrombosis, or it may be the consequence of a preceding epileptic fit, or due to a rapidly spreading œdema in cases of cerebral tumour or abscess. (b) Various toxic agents may induce coma, they may be introduced into the system from without, as in the case of alcohol, opium, or other narcotics, or may be developed within the body, as in uræmia or diabetic coma. (c) Heatstroke or exposure to cold may also lead to unconsciousness. In the latter case there can be but little doubt as to the cause, since the patient is cold, pale, and in a state of severe prostration, in the former the diagnosis may for a time be doubtful. (d) Lastly, it must not be forgotten that two or more of these conditions may co-exist. Thus, a drunken man may fall and break his skull, and then the smell of liquor in his breath may lead to an erroneous diagnosis.

It is therefore evident that a very careful examination of the patient

is required before any conclusion can be arrived at as to the cause of the coma, and it is often impossible to make an immediate diagnosis. In such cases the patient should be carefully tended and watched, and not shut up for the night in a police cell without attendance.

The following points should always be observed in the examination—(1) A rapid note should be made as to the surroundings of the patient—whether there is blood or vomit near him, how the body is lying, and the nature of the ground. (2) The depth of the coma should be ascertained, and, if possible, the man should be roused, and asked to give an account of himself. (3) A most thorough and complete investigation should be made as to his condition. His skull must be first examined, to settle if possible whether or not a fracture is present, the surface temperature of the body is noted, as also the character of the pulse and respirations. The tongue should be looked at, as it is often bitten in an epileptic fit, and the smell of the breath should also be noted. The condition of the pupils may throw some light on the case, in opium-poisoning they are small and equal, a condition also seen in hæmorrhage into the pons, in alcoholism they are often dilated and fixed, but vary considerably in different cases. The amount of power and the state of the reflexes are then observed, any inequality probably indicating a unilateral lesion in the brain. The urine must be drawn off, and carefully examined for albumen and sugar. (4) In dubious cases, and especially where there is any suspicion of drunkenness or poison, the stomach should be emptied and washed out. (5) Finally, if the cause is still uncertain, the patient should be put to bed and carefully watched.

The Treatment of compression must be, where possible, directed to removing the cause. When it is due to depressed bone or a foreign body, immediate operation is required, collections of pus should be opened and blood clots removed. Failing such measures, the treatment of the condition resolves itself into keeping the patient quiet, with the head low and cool, the room dark and noiseless, the bowels open (using croton oil on sugar, or enemata, for this purpose), and the bladder empty. The patient may have to be fed by the rectum, and if the breathing or pulse is very laboured, and cyanosis begins to show itself, venesection may be advisable. Considerable interference with the respiration arises from falling back of the tongue, as often occurs in profound anæsthesia during surgical operations, and if due to this cause the head may be rolled over to one side, or the tongue pulled forwards. Occasionally patients remain in this condition for weeks or months.

**Laceration of the Brain**—Injuries to the brain and its membranes are very frequent complications of blows and falls on the head, and all the most serious results of these accidents arise from this source. They are produced in many different ways, and cause very varied symptoms, but the most important distinction to draw is between those wounds which communicate with the exterior and those which do not.

I **Non-penetrating Wounds of the Brain** result from blows and falls, which may or may not produce simple fissured or depressed fractures of the skull, but not unfrequently the most serious cerebral symptoms follow injuries in which the bones do not participate. In depressed fractures the brain is usually most contused or torn immediately below the injured spot, but in cases where there is no depression, the greatest mischief is frequently found at a point exactly opposite to that struck (point of *contrecoup*), whilst the local bruise may be much slighter. Thus, in the case of one of our students who, in an epileptic fit, fell, striking the left occipital region on a stone pavement, we found *post-mortem* a fissured fracture at the spot struck and a bruise on the left occipital convolution, whilst the anterior portion of the right frontal lobe was severely contused, and, indeed, disintegrated. The explanation of this fact is that the force of the injury is transmitted to the brain substance in a wave which concentrates its violence against the opposite side of the skull. In very sharp sudden localized blows, as from a spent bullet, local bruising of the subjacent brain may be alone produced.

**Pathological Anatomy**—The *immediate* effects of such an injury vary considerably. There may be a mere bruise, evidenced by a few points of extravasation, on the surface or in the gray matter, or the more superficial parts of the brain may be totally disintegrated and mixed with clots, or, if laceration has occurred, clots may be found adhering to the injured spot, or extending from it widely into the subarachnoid space, or even, under rare circumstances, into the lateral ventricle. The *later* effects in cases where the wound does not communicate with the exterior are mainly those of inflammation or degeneration. Soon after the accident considerable exudation follows, causing the ecchymosed brain substance to swell and become œdematous, this may speedily subside, but in the more serious cases a *spreading œdema* may be caused, owing to the pressure of the swollen tissues upon the superficial veins in the pia mater, the circulation in these is hindered, and increased exudation follows, leading to general cerebral pressure and even death, a consequence hastened by the excess of cerebro-spinal fluid usually induced by the process. Under such circumstances the greater part of the brain is œdematous and glistening, the injured area being yellowish-red in colour, with evident points of extravasation scattered through it. Still later, degeneration of the brain substance may follow owing to the disturbance of its circulation, and is indicated by the presence of a pulpy yellowish mass, soft enough to be washed away by a stream of water, and containing fat globules and granular cells, with débris of nerve fibres (*yellow softening*). If the area involved is small and unimportant, the patient may recover perfectly, the softened tissue being absorbed; if large or implicating important centres, death or paralysis must ensue. In cases of laceration of the brain which recover, a tough depressed cicatrix is formed, usually adherent to the membranes, and containing hæmatoidin crystals, whilst extravasated blood may be organized into a dirty



brownish lamina, adherent to the pia mater, or into an arachnoid cyst

**Clinical History**—The symptoms necessarily differ with the severity and locality of the lesion

Whenever concussion occurs after a head injury, and the patient recovers slowly from it, the surgeon will rightly suspect contusion or laceration of the brain. In the slighter cases recovery is often inaugurated by an attack of vomiting, and this is followed by a rise of temperature to about 100° F for a few days, whilst the patient complains of fixed pain and headache, which under suitable treatment may entirely disappear. Some impairment of sense or function may, however, persist.

More serious lesions give rise to various symptoms resulting from hæmorrhagic effusion, and these will manifest themselves either at once or within twenty-four to forty-eight hours of the injury. Thus, if the phenomena of compression supervene at once, without any interval of consciousness, a diagnosis of depressed bone or a serious hæmorrhage into the cerebral substance may be safely made. If, on the other hand, the patient rallies for a time before the incidence of compression phenomena, an extradural hæmorrhage from the meningeal vessels or venous sinuses may be suspected, or a rapidly spreading œdema.

Hæmorrhage into the cortex is characterized by irritative or paralytic phenomena, which vary with the cortical area involved. The question of unconsciousness depends on the amount of the hæmorrhagic effusion.

In the *Upper and Middle Frontal Convolution* neither motor nor sensory symptoms are noted, but cerebral irritation and subsequent weak-mindedness are likely to follow, especially if the left side is seriously involved, lesions to the right frontal lobe do but little harm to a right-handed individual. Apparently, the intellectual faculties are limited to one side of the brain, in the same way as the power of speech.

Wounds of the *Third Left Frontal Convolution* lead to motor aphasia, *i.e.*, the inability to produce or articulate words, in right-handed individuals, in left-handed people wounds of the right side have a similar result. Injury to the opposite convolution has no effect. If only one side is damaged, the other convolution can after a time be educated so as to take on the function of the damaged region.

Hæmorrhage into the *Motor Area* (Fig 277) results in localized convulsions or paralysis, according to the degree of mischief. If the bleeding is progressive, a regular extension of the convulsions may be witnessed, the movements commencing, perhaps, in some region which is at the time incapable of voluntary movement, and spreading to other parts of the body. Thus, if bleeding is occurring into the cortical centres for the face on the left side of the body, paralysis of the right side of the face may be present, and it is here that the convulsions will start, spreading regularly to the right side of the neck, arm, and leg, and then involving the left leg, arm, and side of

the head in order, finally becoming general, as in an epileptic fit After each convulsion the paralysis is found to have spread

It is sometimes very difficult to diagnose between a true cortical hæmorrhage and one which extends diffusely over the cortex in the subarachnoid space from the rupture of a vein in the pia mater In the latter, however, the paralysis is less marked and the convulsions less regular, though perhaps more generalized, but the symptoms of compression develop sooner

Wounds of one *Occipital Lobe* may cause a temporary hemiopia,

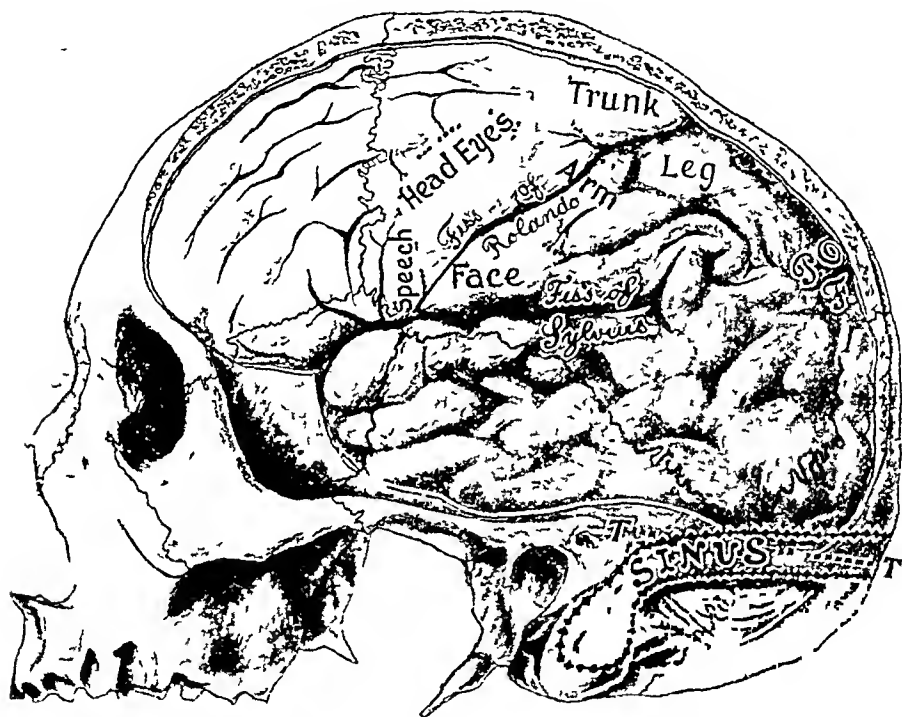


FIG 277 —ARRANGMENT OF THE MOTOR CORTICAL CENTRES AROUND THE FISSURE OF ROLANDO IS INDICATED

P O F, Parieto-occipital fissure T T tentorium, below which is seen the cerebellum The sutural lines of the bones are also visible

but no persistent loss of vision, unless the angular gyrus is also destroyed Lesions of the latter region are always associated with permanent disturbances of vision

The *Upper Temporo-sphenoidal Lobe* contains the cortical auditory centre, and lesions in this region cause deafness the function of the middle and lower lobes is not yet ascertained with certainty

Injury to the *Corona Radiata* leads to paralysis of the regions represented by the overlying cortex, but without convulsions or other irritative phenomena If the corpus striatum or internal capsule is torn or involved in a hæmorrhage coma rapidly supervenes, accom-

panied by hemiplegia and perhaps hemianæsthesia. Occasionally the hæmorrhage bursts *into the lateral ventricle*, and causes a rapid rise of temperature, increasing until the patient's death, together with a very rapid weak pulse and increased respiratory rate (40 to 60 per minute).

Wounds of the *Cerebellum* cause giddiness, vertigo, and ataxy, the patient reeling about in a most characteristic manner, as if drunk.

A wound of the *Crus Cerebri* occasions more or less complete hemiplegia of the opposite side of the body, associated with some amount of hemianæsthesia and total paralysis of the 3rd (oculo-motor) nerve on the side of the injury.

Laceration or contusion of the *Pons Varolii*, if not immediately fatal, may lead to paralysis of the opposite side of the body to the injury, together with paralysis of the 5th, 6th, 7th, or 9th nerves, on the same side as the lesion, constituting the so-called 'crossed paralysis'. Marked contraction of the pupils (myosis) may also be present.

Wounds of the *Medulla* are usually fatal. If, however, the patient should escape, he is liable to suffer from disturbed functions of the circulatory and respiratory centres, with perhaps Cheyne-Stokes respiration and saccharine diabetes.

The later results of a cerebral laceration vary much. The patient may recover perfectly after a more or less prolonged period of unconsciousness, but not unfrequently some loss of power persists, which will seriously impair the patient's subsequent usefulness.

The febrile phenomena already mentioned as characteristic of the first few days of convalescence after an attack of concussion may pass into a condition of subacute or chronic localized inflammation of the injured area, as indicated by pain and headache. In such cases the pressure of effusion may be so great as to determine the onset of unconsciousness in four or five days. Occasionally an abscess forms deeply in the white substance, and this will be indicated by the usual phenomena of such a condition, coming on ten or fourteen days after the injury.

The formation of cicatrices between the brain and membranes may determine the development at a later period of traumatic epilepsy or insanity.

The Treatment of these cases is always an exceedingly anxious matter for the surgeon. In the majority of instances it is merely symptomatic, following the usual course adopted in concussion, compression, cerebral irritation, etc., as indicated elsewhere. The patient is kept absolutely quiet in bed, with an icebag to the head, and a purge administered. Depressed bone, if present, will, of course, be dealt with by operation. Early convulsions and paralysis are carefully watched to see if any indication as to the site of the bleeding can be obtained, since it is possible that trephining over the injured spot and removing blood-clots or securing bleeding-points might be advisable, but the clinical records as to such treatment are not very encouraging. Late convulsions and paralysis due to inflammation are best treated by shaving the head and applying an ice-cap. If

the pulse is full and hard, and the patient otherwise young and healthy, general venesection may be adopted, the bowels must be moved by a smart purgative, such as croton oil, whilst bromide in full doses may be administered. If the convulsions continue in spite of such treatment, and become more severe and extensive, the patient will almost certainly die of coma, trephining over the injured area is then distinctly indicated, the surgeon hoping to find and remove some clot, or, at any rate, to relieve tension within the dura.

II Penetrating Wounds of the Brain result from blows or falls, as in compound depressed fractures, or from the entrance of foreign bodies, such as bullets, or from stabs or punctures which most commonly occur in the weaker parts of the cranium, *e g*, the temple or upper wall of the orbit, or from sabre cuts or axe-wounds, in which an oblique or almost valvular incision is made through the scalp and cranium, laying bare and wounding the brain and its membranes.

In these cases the general disturbance is often slight, compared with the extent of the local injury, so that, although brain substance may protrude from the wound, there is sometimes but little concussion. Any of the conditions due to hæmorrhage detailed below may follow, but they may be less severely felt, except in cases where the bleeding is into the substance of the brain, since the blood can escape from the wound. The inflammatory phenomena following such lesions are mainly *septic* in origin, and may be localized or diffuse. In the latter instance general meningo-encephalitis manifests itself in the course of two or three days, and is rapidly fatal, in the former case adhesions prevent the extension of the trouble beyond the neighbourhood of the wound. Hernia cerebri is very likely to follow, and not unfrequently a deep cerebral abscess will complicate matters at a later date. In cases that have been successfully rendered *aseptic*, the course is similar to that run by a non-penetrating wound, except that, if anything, the immediate prognosis is better, since the opening in the skull and the possible removal of damaged brain substance diminishes the likelihood of compression from simple or spreading œdema. Where the lesion has involved the motor area, permanent monoplegia may persist, and traumatic epilepsy is always liable to result owing to the possible formation of cortical adhesions.

The Symptoms arising from a penetrating wound of the brain have been in measure indicated above. In the worst cases immediate death may result, or severe concussion, merging quickly into compression, from which the patient never recovers. In the less serious cases there will be a varying degree of concussion, followed after a short interval by the phenomena of inflammation, localized or diffuse, which will be subsequently described. Focal symptoms may also arise from destruction of the cortical centres.

Treatment—In all cases of punctured or compound depressed fracture, we have stated that a thorough exploration of the wound should be made, and all depressed or injured bone removed. Foreign bodies should be also taken away if found close to the wound, but

it is doubtful whether a bullet should be sought for, if it has penetrated deeply into the brain, or if it has traversed the brain and fractured the bone on the other side. Probably an aseptic incision, with removal of the splintered fragments and a limited search for the bullet, is the best treatment to adopt, and, even if unsuccessful, will do but little harm, if the patient's general state warrants an operation. When he is evidently moribund, it is better practice not to interfere. Protruding brain tissue is gently removed, and the whole wound thoroughly purified with carbolic lotion, even the 1 in 20 solution may be used without fear. The dura mater should, if possible, be drawn together by one or two sutures, and a small drain-tube or a gauze wick inserted within it. It is often advisable to introduce a portion of sterilized gold foil between the cortex and the dura, so as to prevent the formation of adhesions. Fragments of bone, if kept warm and aseptic, may be replaced (p 757), and the scalp-wound closed, except at the drain opening, the gauze or tube should be removed, if all is going well, in about two days' time. If the temperature rises as a result of septic infection, the wound must be re-opened, and every effort made to relieve tension, and thus localize the mischief. Should diffusion occur, as indicated by an increasing severity of the symptoms, the patient must be treated in accordance with the general principles laid down for dealing with acute meningitis.

In this description of lacerations of the brain we have purposely omitted any mention of the fact that symptoms may arise from inflammatory conditions affecting the bones (p 745). In actual practice the course of events is often considerably modified by such a complication.

### Injuries to the Intracranial Bloodvessels

1 **Wounds of the Venous Sinuses** are by no means uncommon, being torn across in fractures, or punctured either by some sharp instrument, or by spicules of bone. The superior longitudinal, petrosal, lateral, and cavernous sinuses are those most frequently involved, especially the first, because it is more intimately connected with the bones than any of the others. When there is no external wound, and only the outer wall of the sinus has been opened, the hæmorrhage may strip up the dura mater and compress the brain, producing effects resembling those due to meningeal hæmorrhage, but generally the bleeding is not great, since comparatively little pressure suffices to arrest it by flattening the sinus against the bone. If, however, the inner wall of the sinus is torn across, the blood finds its way between the meninges, and gives rise to the symptoms of diffuse intrameningeal hæmorrhage. When an external wound exists, there is the usual evidence of venous bleeding, but it is readily checked and rarely fatal. Septic thrombosis and pyæmia are the chief dangers, but entrance of air has also led to a fatal issue in a few cases. **Treatment**, when practicable, consists in plugging the sinus

with aseptic gauze, and applying an antiseptic compress, possibly removing fragments of bone in order to expose it. Where the outer wall alone has been torn, it may be possible to suture it without interfering with its continuity. For symptoms and treatment of septic thrombosis, see p 784.

2 **Wounds of the Middle Meningeal Artery**—This vessel enters the skull at the foramen spinosum, and subsequently divides into two branches which ramify between the skull and the dura mater. The

anterior branch is most frequently injured as it crosses the antero-inferior angle of the parietal bone, as the result of any type of fracture in that locality. The artery is, however, sometimes ruptured by a blow on the side of the head, sufficiently severe to detach the dura mater, but without causing any injury to the bone, this membrane always carries the vessel with it, and if it emerges from a bony canal just at that spot, as so often happens, the artery is torn across by the projecting inner lip of the canal. Whether or not the dura is primarily detached, the blood soon collects between it and the bone, pressing the brain inwards, and bur-

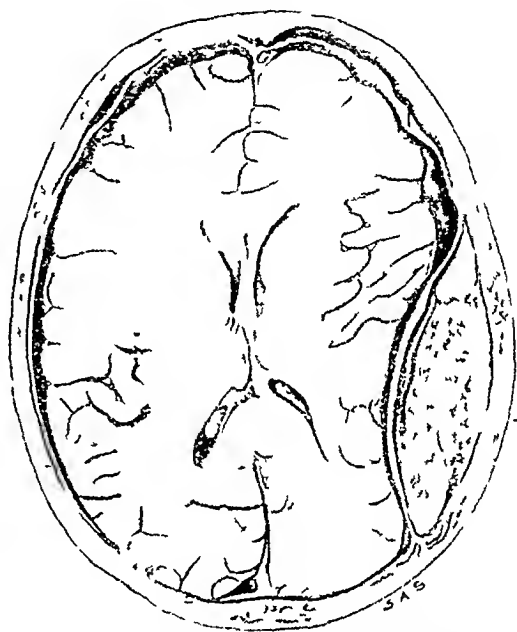


FIG 278—MENINGEAL HÆMORRHAGE  
(FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM)

rowing down towards the base of the skull (Fig 278). Such is due mainly to the force-pump-like action of the arterial pressure, for when fluid is driven into a closed cavity, the power of the jet is multiplied by the area occupied. The clot rarely measures more than 4 inches in diameter. The posterior division is only wounded in about 5 to 10 per cent of the cases.

The **Symptoms** are, unfortunately, often obscured by some co-existent cerebral lesion or complication, but in a typical case three stages should be present, viz (a) A primary concussion, as the result of the blow, (b) a temporary return to consciousness, and (c) the gradual supervention of coma within twenty-four hours, and that usually without any considerable rise of temperature. The interval of consciousness varies widely, but it is not often longer than an hour or two, whilst in many cases it is scarcely recognisable. As accessory signs, the following may be mentioned (x) Since the blood-clot is situated close to the motor area of the cortex, and especially over

the centres for the head and arm, twitching of these parts, followed perhaps by paralysis, may be a well marked feature, and usually supervenes before the onset of coma, (2) when the clot extends to the base of the skull, it presses on the cavernous sinus, and may induce passive congestion of the eyeball, paresis of some of the ocular muscles, and proptosis, with possibly a dilated pupil and high temperature, and (3) when a fissure exists in the bone, blood may filter through into the temporal fossa, and cause a marked fulness in that region. The **Prognosis** is extremely unfavourable, Von Bergmann stating that out of ninety nine cases only sixteen recovered.

The **Diagnosis** of extra dural hæmorrhage is easy if there is an open wound, or if the symptoms are at all typical, but even then one cannot be certain that the middle meningeal artery has given way, and that the symptoms are not due to venous bleeding. An examination of the injury and of the part struck, and the rapidity of onset of the symptoms, may help in this matter, but it is often impossible to make a diagnosis with certainty.

The **Treatment** consists in trephining in order to remove the blood-clot and secure the artery, if still bleeding. The spot selected for dealing with the anterior division of the artery is  $1\frac{1}{2}$  inches behind the external angular process of the frontal bone, and  $1\frac{1}{2}$  inches above the zygoma (Fig 281, F), and this point should be marked on the bone with a bradawl through the scalp before commencing the operation. The scalp is shaved and thoroughly purified, and a flap turned down, including everything as far as the pericranium (Fig 90, A). A crucial incision is then made over the selected spot, and the pericranium reflected sufficiently to allow a 1-inch trephine to be applied. On removing the disc of bone, a mass of blood clot presents, which should be broken up with the finger and washed or scraped away. If the artery is seen bleeding on the dura mater, it may be possible to pick it up, and tie or twist it, or a fine curved needle threaded with catgut may be passed under it, and thus a ligature applied. If, however, the blood comes from a canal in the bone, the outer table must be clipped away sufficiently to enable the canal to be seen and plugged by a small piece of aseptic wax, sponge, or gauze, which may be left without danger. The flap is then replaced, and stitched down, a drain-tube being inserted for a time.

The posterior branch of the artery can be reached by trephining immediately below the parietal eminence at the same level as for the anterior branch—i.e.,  $1\frac{1}{2}$  inches above Reid's base line, or, again, it can be exposed nearer its origin at a spot  $1\frac{1}{4}$  inches behind the external angular process of the frontal bone, and  $\frac{1}{4}$  inch above the upper margin of the zygoma (Fig 281, G).

3 **Wounds of the Internal Carotid Artery**, in its intracranial portion, are rare, but if complete are necessarily fatal. They usually result from penetrating wounds of the orbit, or from a gunshot wound, or the vessel may be torn by a splinter of bone in a fracture of the base of the skull. Mere fissures through the carotid canal do

little harm, since there is plenty of room within it around the artery. Occasionally, however, the artery is slightly torn, and an aneurismal varix develops between it and the cavernous sinus. Of seventy-five cases of pulsating exophthalmos, Rivington found that forty one were caused by trauma, and were probably of this nature. **Treatment**—The injury is fatal in the majority of cases before help can be obtained, if not, compression or ligature of the carotid trunk in the neck is the only hope. See also on intra-orbital aneurism (p. 320).

4 **Intrameningeal Hæmorrhage** arises from wounds of the cerebral cortex or membranes in cases of fractured skull, or from concussion without fracture. The blood may be derived from the veins and capillaries so abundantly present in the pia mater, or from lesions of the inner wall of venous sinuses, or even from the middle meningeal artery, if the dura mater is also opened. It may be widely diffused over the surface of the hemispheres, or be more localized. It is often but slowly absorbed, and may become encapsuled, constituting what is known as an arachnoid cyst—*i.e.*, a closed cavity containing serum, the walls of which are formed of fibrous tissue stained brown with hæmatin.

The **Symptoms** are those of cerebral compression, supervening directly on concussion, though sometimes after a conscious interval. When the bleeding is not very severe, the coma is often of long duration, though, as a rule, not of great intensity. Perfect recovery may ensue, even though unconsciousness is prolonged for weeks, but adhesions may form as the result of a chronic meningitis lighted up by the accident, and these may lead to subsequent trouble. No focal symptoms are produced unless the hæmorrhage arises from or presses upon the motor area, when convulsions, or later on paralysis, may ensue. If, however, the blood escapes from one of the large venous sinuses in the base of the skull, *e.g.*, the cavernous, which may be torn in a fractured base, the patient may pass into a condition of deep coma in a few hours, and may die in a few days.

The **Treatment** is symptomatic, the patient being kept absolutely quiet, and all excitement and noise which might induce cerebral congestion excluded. Should there be any focal symptoms indicating the position of greatest pressure, or should there be some concurrent lesion of the skull, the trephine may be applied at this spot. It must not be forgotten, however, that the chief hæmorrhage often occurs, not at the point to which the injury was directed, but at an exactly opposite spot on the other side of the cranium, and hence considerable uncertainty may arise both as to the advisability of an operation and as to its site. Should the right locality have been exposed, the dura mater will probably bulge into the wound, after the circle of bone has been removed, it is blackish blue in colour, owing to the clot lying beneath it, and the cerebral pulsations will not be detected. It is carefully incised, and the blood-clot removed, any bleeding points should be tied or compressed, or it may be necessary to insert a small wick of aseptic gauze for a day or two, in order to drain off serum and blood.



5 **Cerebral Hæmorrhage** occurs more frequently from idiopathic causes than from trauma, except in the case of severe lacerations. In the more aggravated forms, death is almost certain to follow in short time from coma.

### Intracranial Inflammation

Inflammation of the cranial contents is almost always bacterial in origin, and may follow a great variety of lesions, *e.g.* (1) Injuries of all types, but especially compound or punctured fractures. (2) Middle-ear disease is perhaps the most frequent origin of these affections, the infection reaching the brain through an opening in the tegmen tympani, or spreading from the mastoid process along the sigmoid groove in which lies the lateral sinus. (3) It may extend inwards from scalp, face, or neck by way of the emissary veins, or even along the sheaths of nerves. (4) It may accompany simple contusion of the cranial bones (p 747), as a result of an auto-infective inflammation in these structures.

The causative bacteria are generally of the usual pyogenic type—*i.e.*, staphylococci and streptococci, but the pneumococcus is not uncommon, and in the pus of cerebral abscesses the *B. pyocyaneus* and *B. coli* are occasionally found. In the so-called idiopathic form of diffuse meningitis the *Diplococcus intracellularis* of Weichselbaum is generally the causative organism.

It must be remembered that in actual practice the different forms of inflammation described below run into one another, and that the resulting symptoms are often a complex mixture of several types. For descriptive purposes the following groups may be differentiated.

(1) **Subcranial Inflammation**, which manifests itself either as a simple thickening of the dura (*pachymeningitis*), or as an effusion of pus between the dura and the bone (*subcranial abscess*).

**Simple Pachymeningitis** results either from a slight simple depressed fracture, or from a contusion with or without a fissured fracture, or from the gradual spread of a mild infective inflammation from the overlying bone. The process is really protective in character, the dura becoming thickened. It may extend to the under surface of the dura, and lead to a localized lepto-meningitis, characterized by adhesions between the cortex and the dura. If the process extends no further, the clinical manifestations are slight, consisting merely of pain and localized headache. For treatment, see chronic meningitis (p 784).

In some forms due to infection, the process continues and leads to an acute or subacute diffuse meningitis.

**Subcranial (or extradural) Abscess** results from either a compound depressed or a punctured fracture, in which the dura mater is only separated from the bone and not lacerated, especially when the external wound is small and efficient drainage is not obtained. It sometimes occurs, however, in consequence of a simple contusion or fracture of the skull, leading to a detachment of the membranes and

a collection primarily of blood and later of inflammatory fluids in the cavity thus produced. Microbic invasion is here due to auto-infection, or to the passage of organisms through the bone. Any form of osteo-myelitis of the cranial bones may determine its onset, but apart from injury, its most common cause is, without doubt, extension of inflammation from the middle ear.

A perforation of the tegmen tympani allows of the invasion of the cranial cavity, and an abscess forms above the attic, which, perhaps, discharges through the ear, in other cases the suppuration extends along the groove for the lateral sinus. In the former instance a localized subdural abscess may subsequently develop, limited by meningeal adhesions, and the intervening dura mater may slough, in the latter thrombosis of the lateral sinus may follow.

The **Symptoms** produced are (1) those generally characteristic of suppuration, viz, a high temperature, with perhaps rigors. (2) The

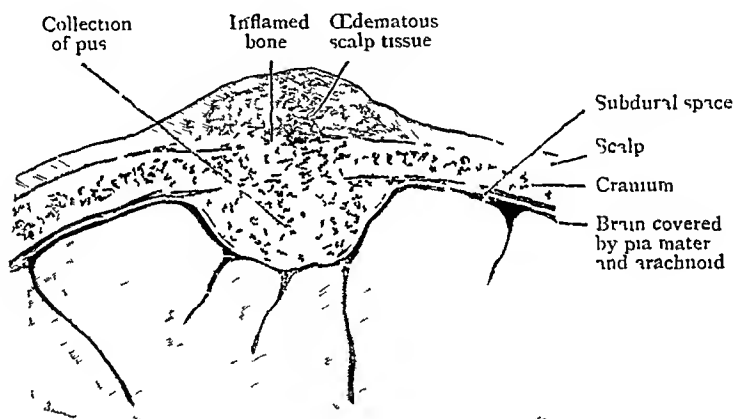


FIG 279.—SUBCRANIAL SUPPURATION, INVOLVING OVERLYING BONE AND CAUSING AN ŒDEMATOUS CONDITION OF THE SCALP—POTT'S PUFFY SWELLING (SEMI-DIAGRAMMATIC) (FROM TREVES 'SYSTEM OF SURGERY')

signs of intracranial pressure in the form of fixed headache followed by coma are also present. (3) If there is no open wound, an œdematous swelling of the scalp, known as *Pott's puffy tumour*, may develop over the site of the abscess (Fig 279). When there is a compound fracture of the skull, the margins of the wound look unhealthy, and at its base may be seen bare bone, yellow and dry, from which the pericranium has separated, with perhaps pus oozing out between the fragments. If the pus burrows towards the base of the skull, optic neuritis may develop. (4) Focal symptoms of spasm or paralysis may complicate the case if the dura over the motor area is involved. The **Treatment** of such a condition consists in evacuating the abscess cavity through a sufficient opening made by trephining, or by removing loose or diseased portions of bone, and providing for drainage. Sometimes more than one opening is required for this purpose.

When the affection follows middle-ear mischief, the mastoid

antrum is usually opened up, as also the attic, and a sufficient amount of bone gouged or cut away to give effective drainage

(11) **Acute Diffuse Meningitis (lepto-meningitis)** is always infective in nature. The symptoms vary considerably in their intensity according to the site and method of inoculation and the activity of the organisms, but the whole *pia-arachnoid* space is quickly involved. The superficial part of the brain is also invaded in the inflammation as well as the meninges, and the term *meningo-encephalitis* would perhaps be the better appellation.

The **Symptoms** appear about forty-eight hours after an injury, although sometimes infection may be delayed beyond this period. In the early stages the patient complains of severe, constant, and increasing headache, associated with heat of head, a forcible pulsation of the carotids, a quick pulse, and general irritability of the brain, as indicated by vomiting, intolerance of light and sound, delirium, and perhaps convulsive twitchings of the muscles, not only of the head and back, but also of the extremities. The vomiting is of the usual cerebral type, *i.e.*, it occurs apart from nausea, and has no relation to the ingestion of food. High fever is usually present, and possibly a rigor may occur at the onset. As the disease progresses, the patient gradually becomes comatose, the pulse slow and full, the respirations laboured, and death usually ensues in three or four days.

According to the site of infection, the inflammatory phenomena may manifest themselves more acutely over one part than another, and for descriptive purposes two chief varieties have been distinguished, *viz.*, meningitis of the convexity and meningitis of the base. The general symptoms are alike in both forms, but when the convexity is involved, convulsions are a more prominent feature in the case, and may at first be limited to localized groups of muscles, whilst in basal meningitis the temperature tends to run higher, the head and neck are more retracted, optic neuritis is more frequent, and some form of squint is not uncommonly observed.

On *post-mortem* examination the skull-cap is separated from the meninges with some difficulty, the *dura mater* is thick and congested, and the subjacent veins are manifestly distended, the cerebro-spinal fluid is increased in amount, and turbid from admixture with lymph or pus, the arachnoid is thick and opaque, the surface of the convolutions is flattened and oedematous, and lymph occupies all the sulci, matting them together, the cortical gray matter is usually red and congested, the underlying white substance of the *centrum ovale* is injected, numerous *puncta cruenta* being evident, the ventricles are distended with cerebro-spinal fluid, and the choroid plexuses are engorged with blood.

The **Treatment** consists in shaving the head and applying cold by means of an icebag or Leiter's tubes, care being taken that the application is continuous, and not intermittent. In the robust general venesection is useful, but in weaker individuals cupping or leeching may replace it. The bowels are freely opened and a bland diet ordered. The patient should be kept absolutely quiet in a darkened

room, and every source of irritation and excitement removed. Even if recovery ensues, it is somewhat delayed, and similar precautions as to quiet, etc., must be maintained for some time. In the later stages, blistering of the scalp or neck, and the administration of mercury, are advisable.

If the condition is due to a localized infective lesion, this must, of course, be dealt with by suitable means, *e g*, the middle ear must be opened up and diseased bone removed, depressed fractures must be operated on, and localized drainage effected, etc. Apart from this, attempts have been frequently made to relieve the symptoms and determine a cure by means of operative measures, directed towards reducing the intracranial tension, the subarachnoid space has been opened below the tentorium, whilst others have utilized Quincke's plan of puncturing the spinal membranes between the third and fourth lumbar vertebræ, *i e*, below the termination of the spinal cord (p 764)

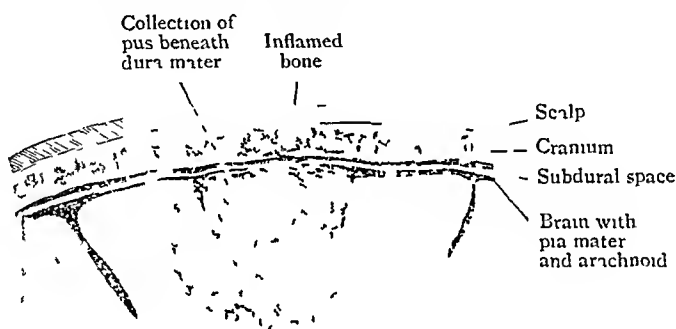


FIG 280.—SUPERFICIAL ABSCESS OF BRAIN SPREADING FROM SUBDURAL SPACE (SEMI DIAGRAMMATIC) (FROM TREVES' 'SYSTEM OF SURGERY')

In no case of acute meningitis has a successful result followed, and when one considers the intricate character of the space to be drained, the fact that it is sure to be subdivided into separate cavities by deposits of lymph, and especially when it is remembered that the brain substance is itself swollen, and that the important fourth ventricle only communicates with the subarachnoid space through the small foramen of Majendie, which is certain to be blocked early in the case—all these considerations go to prove that it is useless attempting any such measures.

**Acute Meningo encephalitis** is sometimes *limited* in character. Such can only occur when there is no tension from retained discharges, diffusion along the meninges being prevented by the formation of adhesions. Localized subdural suppuration is usually present, involving even the brain substance, but with care recovery is possible, although an adherent cicatrix will be formed, perhaps giving rise to subsequent epileptic symptoms. It usually results from a localized inflammation of bone (Fig 280), due to a contusion, a penetrating wound, or possibly to middle ear mischief.

(iii) A Subacute form of meningitis is occasionally met with, coming on at a somewhat later date. The patient may have apparently recovered from his injury, with the exception of a fixed pain in the head. The onset of the symptoms is often due to some indiscretion, and may be gradual or sudden. In all probability this affection is also microbic in origin, and the delay in its appearance depends either on the small number of bacteria present, or on their being in a low state of virulence, or possibly they have been latent for a time, and are aroused into activity by later causes, or, again, they may have gradually worked their way inwards along lymphatics or vessels from the periphery to the meninges. The symptoms are similar in character to those of acute meningitis, though somewhat less severe, but a fatal result is very apt to follow. In the *treatment* of this form, no active antiphlogistic measures should be adopted, since the patient's condition is somewhat asthenic. Absolute rest and quiet are essential, counter-irritation should be applied to the scalp and neck, and possibly mercury administered.

(iv) **Chronic Lepto-meningitis** arises from very similar causes to the pachymeningitis already described (p 780), but in addition may be associated with deep lesions, and may serve to limit the spread of infection, it is usually of a protective character. Syphilitic patients are perhaps more liable to its development than others. It is evidenced by infiltration and thickening of the membranes, which are usually adherent to one another and to the cerebral cortex. It gives rise to a localized headache, which is constant, and increased on excitement or the injudicious use of stimulants, whilst tenderness is often noted on deep pressure, and traumatic epilepsy may ensue. The *treatment* consists in attention to the general health, free action of the bowels, abstinence from excitement or stimulants, the local application of counter-irritants, and possibly the administration of mercury. For the question of operating for traumatic epilepsy, see p 793.

(v) **Tuberculous Meningitis** is a condition usually seen in children, due to an invasion of the meninges with tubercle. The pial vessels are chiefly affected, and the base of the brain is mainly involved. Inflammatory adhesions follow, and the free circulation of the cerebro-spinal fluid is checked by the blocking of the foramina of Majendie and Monro, so that the ventricles are often distended. For symptoms and clinical history, medical text-books must be consulted.

Many attempts have been made to deal with this affection by surgical means, especially by trephining through the occipital region and draining away the cerebro-spinal fluid, so as to relieve pressure on the fourth ventricle. One or two cases have recovered *post hoc*, but the prospects of success are indeed poor.

(vi) **Infective Thrombosis of the Sinuses**, though occasionally seen after injuries, is more commonly associated with suppurative diseases of the bone apart from trauma, and one variety, viz, that affecting the lateral sinus, is almost exclusively caused by disease of the middle ear. It is also induced by extension from scalp injuries as a

complication of subaponeurotic cellulitis, or may spread inwards from erysipelatous or pyogenic lesions of the face, or suppurative conditions of the nose. Putting aside the results of chronic otorrhœa, the cavernous sinus is much more frequently involved than any other.

Pathologically, the same manifestations are observed as in any case of infective phlebitis. The sinus becomes impervious owing to the presence of a thrombus, and this in turn becomes disintegrated, and gives rise to multiple emboli, whilst various inflammatory conditions of the surrounding tissues necessarily result, *e g*, necrosis or caries of bones, subcranial abscess, meningitis, simple and localized, or septic and diffuse, or even cerebral or cerebellar abscess.

The *symptoms* are mainly of a pyæmic nature. The temperature is high, but with remissions, and often with repeated rigors, fixed headache and early and continuous vomiting are also marked features of the case. With these may be associated evidences of meningeal mischief, or of pulmonary trouble in the shape of dyspnœa, but sometimes diarrhœa and septicæmic manifestations may be the more prominent.

If the cavernous sinus is involved, marked exophthalmos, with congestion of the orbit, and even of the eyelids and face, may result, and ptosis or squint may also be set up by implication of the nerves which lie in the walls of the sinus.

If the superior longitudinal sinus is affected, there may be turgescence of the veins of the scalp and forehead, together with tenderness along the line of the sinus and epistaxis, whilst convulsions may be induced by irritation of the neighbouring motor area.

For local results and treatment of thrombosis of the lateral sinus, see p 890.

**Treatment**, except for the lateral sinus, is but rarely possible, and hence the importance of preventing this disease by a most careful attention to asepsis. For the lateral sinus much can be done, but for the other sinuses all that is feasible is attention to general measures.

### Abscess of the Brain

**Causes** —Pyogenic infection is, of course, the ultimate cause of all cerebral suppuration, but the manner in which the organisms find their way to the brain varies considerably.

(1) It may be due to *traumatism*, either in the early or late stages of head injuries. In the *early*, it is usually superficial, and connected with some infective lesion of the scalp, cranium, or membranes, with or without a penetrating wound (Fig 280). In the *later* stages the pus forms deeply in the white substance. It may be due to a penetrating wound, whether a foreign body is present or not, the microbes finding their way into the interior of the brain either through the track of the missile, or along bloodvessels or lymphatics. Sometimes it occurs apart from penetration, and then one can only suppose that it is due to auto-infection of a contused or lacerated area. Chronic abscess of this type is most frequently seen on the same

side of the brain as the lesion, and the parietal and frontal lobes are most often affected, occasionally, however, it may occur on the opposite side in the same way as a contusion

(ii) It arises by extension of an infective lesion from without, the organisms reaching the brain by direct continuity of tissue, or by way of the bloodvessels or lymphatics. The commonest cause of all abscesses in the brain is *chronic otomhæa*, and the cerebellum is nearly as frequently involved as the cerebrum. In the former the abscess is usually in the anterior portion of the lateral lobe, close to the back of the petrous bone, whilst in the latter the posterior portion of the temporo-sphenoidal lobe is most frequently affected. The inflammation may spread directly from the tympanic cavity or inner aspect of the mastoid process through the bone to the membranes, which become adherent to the brain, and then into the cerebral substance. Occasionally a subcranial abscess is first developed, and the cerebral affection follows, sometimes a direct opening has been found through the tegmen tympani into an abscess cavity, and it has even discharged itself and been drained in this way. More commonly a layer of brain tissue intervenes between the membranes and the pus, and then infection will have been carried along vessels and lymphatic sheaths running from the meninges to the brain, or *vice versa*.

Abscesses of a similar type occur in connection with suppuration in the frontal sinus, the abscess being usually acute and secondary to a frontal osteo-myelitis, and occupying the anterior portion of the frontal lobe, it may also follow purulent infection of the sphenoidal and ethmoidal sinuses, or thrombosis of the cavernous sinus.

(iii) The infective material may be brought to the brain by the blood in pyæmia, or after some of the exanthemata, such as scarlatina, typhoid, etc. Abscess of the occipital lobe is almost always of pyæmic origin.

(iv) A chronic abscess of tuberculous origin may also occur.

A cerebral abscess is usually single, occasionally more than one is present, *e g*, a cerebral and cerebellar may co exist in connection with middle ear mischief. The course taken by the case is generally chronic, and then the pus is encapsuled, in acute cases there is usually no limiting membrane. A chronic case not uncommonly terminates in an outbreak of acute symptoms, due either to the abscess bursting into one of the lateral ventricles, or to the super-vention of spreading œdema.

The **Symptoms** vary somewhat with the method of onset and the characters of the abscess. If traumatic and due to infection from without, the case runs an acute course, associated with intense pain in the head, recurrent rigors, and rapid development of coma. Diffuse meningitis is often present, and the two conditions can scarcely be distinguished. In not a few of the cases of chronic abscess, all that the patient complains of is headache, until suddenly the temperature rises with a bound, he becomes unconscious and dies within a day or two. Such a course of events is probably due to the bursting of the abscess into the lateral ventricle or meningeal cavity, or to the onset of an acute spreading œdema.

When the symptoms are more characteristic, Sir W Macewen describes them in three well-marked stages (1) In the *Initiatory Stage*, which lasts from twelve hours to two or three days, the patient is suddenly seized with severe pain in the region of the ear, radiating perhaps throughout the head, and accompanied by a rigor of some severity. The temperature and pulse are both raised, and vomiting of a cerebral type is present, the tongue is foul, whilst anorexia and constipation are well marked. During this period the otorrhœa diminishes or ceases entirely.

(ii) In the *Fully developed Stage* the patient lies quietly in bed in a dull, apathetic condition, able to answer questions but slowly, and with his brain evidently in a torpid state. The headache has to a great extent ceased, but tenderness over the temporo-mastoid region still remains. The temperature gradually falls and becomes sub-normal, and the pulse is slow and full. Respiration is usually slow, and in cerebellar abscess may be irregular. The vomiting and constipation continue, and the patient's mouth and breath become very offensive. The power of movement usually remains, but focal symptoms may manifest themselves, though in many cases of temporo-sphenoidal abscess they are not marked. If the cortex is mainly involved, the face is first affected, then the arm, and finally the leg, but if the abscess is deeper and presses on the motor fibres in the internal capsule, the order in which these parts are involved is reversed. Motor aphasia is sometimes well marked when the abscess is on the left side. If the abscess is placed posteriorly, it may press on the cerebellum through the tentorium, and cause symptoms of a cerebellar type. Optic neuritis is a somewhat unreliable sign, but if present is more marked on the affected side, whilst the corresponding pupil is dilated and fixed.

(iii) The *Terminal Stage* is marked by a gradually increasing unconsciousness and death, or the abscess may burst into the lateral ventricle, causing sudden coma, a rapid rise of temperature and pulse, irregular respirations (often of a Cheyne-Stokes type), and death, or it may burst into the subarachnoid space, and then death is preceded by symptoms of diffuse lepto-meningitis.

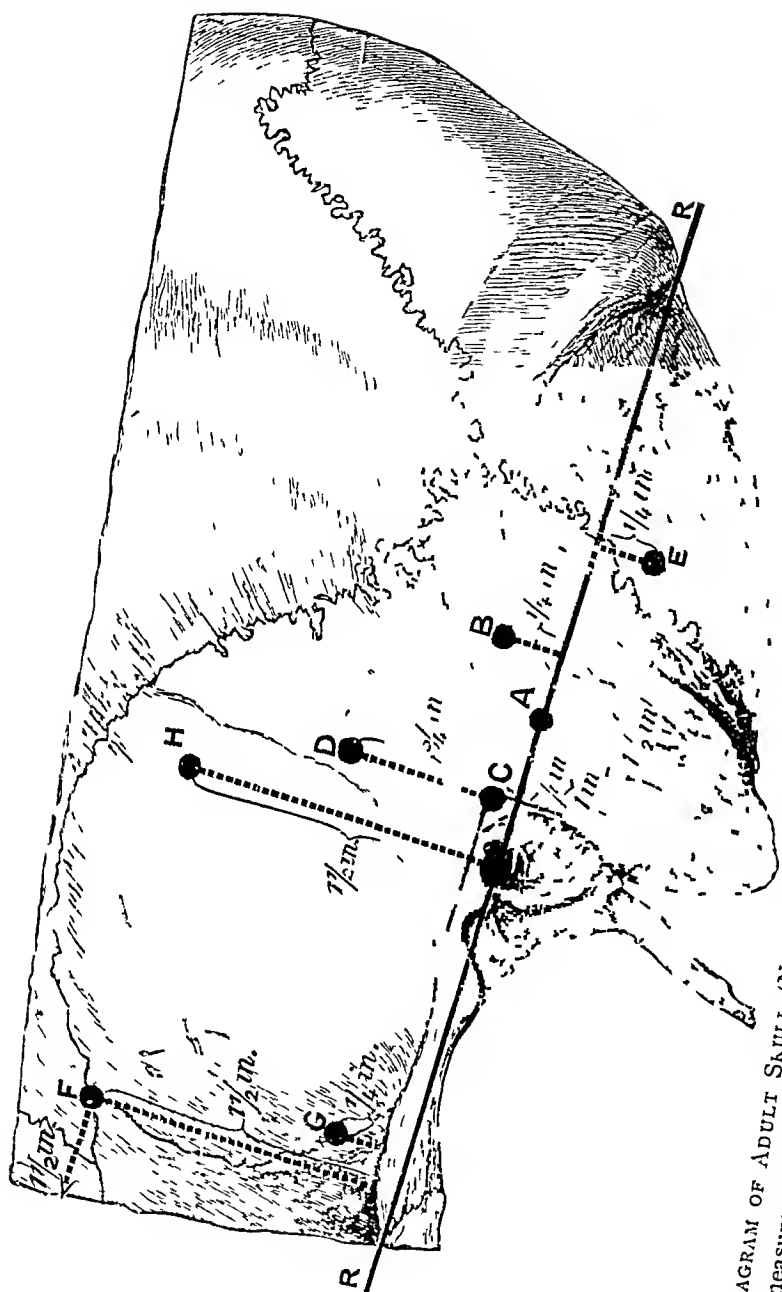
The signs connected with a small **Cerebellar Abscess** are often very indefinite and vague, but if the abscess increases in size, the symptoms may become very characteristic. The patient complains of giddiness, and staggers when attempting to walk, falling towards the opposite side. The head and neck are retracted, respiration is irregular and feeble, the pulse is often slow and weak, paralysis may be noted on one or both sides of the body, and may only affect the upper extremity, of course, vomiting, optic neuritis, and a low temperature are present.

**Diagnosis** — From *meningitis*, a cerebral abscess is usually recognised by the fact that in the former condition irritative phenomena, such as acute and active delirium, contraction of the pupil, photophobia, rigidity and spasm of muscles, especially in the back of the neck, and severe pain, are more evident and are produced earlier. The



temperature is usually high, and mental dulness comes on within three or four days of an injury, whereas an abscess rarely forms before the end of the first week. *Extradural abscess* (subcranial) is associated with a high temperature, earlier onset after an injury in traumatic cases, and more rapid compression symptoms, optic neuritis is unusual, and the vomiting is less troublesome. There is also likely to be some localized œdema or tenderness on deep pressure. In *thrombosis of the lateral sinus* the temperature is high and oscillating, optic neuritis may be absent, and there may be the characteristic tenderness in the neck, in abscess symptoms of compression are associated with a low temperature and marked optic neuritis. It must not be forgotten that the two conditions may co-exist. It is often impossible to diagnose between a chronic abscess and a *tumour of the brain*, the symptoms in the latter usually come on more slowly than in the former, but the progress is steady and unrelenting, the temperature remains near the normal, and there is less gastric disturbance. The history of the case may throw some light upon its nature, since in cases of cerebral abscess there is generally some causative septic focus. Tumour is more common in the frontal and parietal regions, abscess in the temporo sphenoidal lobe. Optic neuritis is more marked and more common in tumour than in abscess.

**Treatment** necessarily follows the usual rule, viz., to give an exit to the pus as soon as possible, no delay is permissible when once the diagnosis is certain. The patient is prepared in the same way as for operation on a cerebral tumour (p 792). A flap of scalp tissue is raised, and in such a manner as will most effectually serve for subsequent drainage purposes. The trephine is applied according to the rules given below, or in accordance with the special indications given by the symptoms of the case. Professor Macewen recommends that, when the circle of bone has been removed, the exposed surface and cut edge should be well rubbed over with powdered iodoform and boracic acid, so as to guard them from infection. The dura mater, which bulges into the wound and does not pulsate, is then carefully incised. A mere slit usually suffices, and this may open the abscess, but more usually the brain substance protrudes. It is carefully explored with a trocar and cannula, which is passed directly into it in various directions, or with a pair of sinus forceps. In a temporo-sphenoidal abscess the most likely direction to explore is downwards and inwards towards the tegmen tympani. Pus having been discovered, is allowed to escape by opening the blades of the sinus forceps. Sloughs are not uncommonly present in the cavity, and are removed by the gentle introduction of a curette, whilst it is wise to wash out the interior by gentle irrigation with sterilized salt solution. A drainage-tube is advisably inserted, and may be kept in position by stitching it to the margins of the incision in the dura, which is closed except for the passage of the tube. Sometimes it is wiser not to close the flaps around the tube, but to pack gauze round it, thereby determining the formation of adhesions, which will serve to shut off and guard from infection the meningeal cavity. The scalp flap is



110 281

—DIAGRAM OF ADULT SKULL (NATURAL SIZE) TO SHOW VARIOUS SPOTS FOR TREPHINING (TREVES' 'SURGERY')

The horizontal measurements are taken along Reid's base line, R, R', which passes through the centre of the external auditory meatus 1 point  $\frac{1}{4}$  inch along the base line from the centre of the meatus B, the mastoid antrum, the point of meeting of the sigmoid portion of the sinus, 1 inch behind the meatus and  $\frac{1}{4}$  inch above the base line C, the other along the posterior wall of the meatus at right angles to the base line D, for temporo splenoidal abscess, a line drawn  $\frac{1}{4}$  inch upwards through the posterior border of the meatus at right angles to the base line E, for cerebellar abscess,  $1\frac{1}{4}$  inches behind the centre of the meatus, and  $\frac{1}{4}$  inch below the base line, F, for anterior branch of middle meningeal  $1\frac{1}{4}$  inches behind external angular process of frontal bone, and  $1\frac{1}{4}$  inches above the zygoma, G, for posterior branch of middle meningeal  $1\frac{1}{4}$  inches behind external angular process, and  $\frac{1}{4}$  inch above the zygoma H, for tapping lateral ventricle  $1\frac{1}{2}$  inches above centre of external auditory meatus

replaced in position, the tube being brought out through its centre, if need be. The tube is retained in position for two or three days, and is then removed. Symptoms of re-accumulation or of extension of the mischief to the meninges will, of course, necessitate a re-opening of the wound, and the institution of free and effective drainage. Occasionally a hernia cerebri develops as the result of opening a cerebral abscess.

For an abscess in the temporo-sphenoidal lobe, the centre-pin of the trephine may be placed  $1\frac{1}{4}$  inches above Reid's base-line, and directly above the external auditory meatus, but a better situation is a spot  $\frac{3}{4}$  inch above the posterior root of the zygoma, and directly above the posterior border of the osseous meatus (Macewen, Fig 281, D). For an abscess in the cerebellum the point selected is  $1\frac{1}{2}$  inches behind the centre of the external auditory meatus, and  $\frac{1}{4}$  inch below the base-line (Fig 281, E). In the latter case the soft parts, including the muscles and periosteum, should be stripped off the occipital bone, and turned downwards, and it is usually inadvisable to apply a trephine, as the bone is very thin, and may be broken through with a gouge. It is often necessary to carry through the cerebellar operation rapidly, as the respirations sometimes stop under an anæsthetic, though the heart continues to beat forcibly, as soon as the dura is opened, the respirations recommence.

In middle-ear disease the diagnosis, both as to the presence of an abscess and its situation, is often doubtful. The antrum and attic are then opened and explored thoroughly, and according to whether the disease is more marked in the former or latter, the further steps of the operation are directed towards the cerebellum or cerebrum. By carefully removing bone behind and above the antrum, the lateral sinus is exposed, and by working above or below it, the cerebrum or cerebellum can be examined, and, if need be, incised. A similar result can be obtained by applying a  $\frac{3}{4}$ -inch trephine to a spot 1 inch behind the meatus and  $\frac{1}{2}$  inch above the base-line (H. P. Dean). The lateral sinus lies in the lower portion of the opening, and the dura over the temporo-sphenoidal lobe in the upper, by enlarging the opening downwards by Hoffman's rongeur, the cerebellum can also be explored.

### Cerebral Tumours

The chief Varieties of new growth met with in the brain are as follows: (i) *Glioma*, which consists of a small round celled neoplasm with a very delicate intercellular substance, similar in character to the neuroglia (p 197), it may occur in any part of the brain. It is always continuous with the surrounding cerebral tissue, and is scarcely ever encapsuled, so that to the naked eye it may be indistinguishable from brain substance, although rather harder, and hence its limits can seldom be accurately defined. (ii) *Sarcomata* also occur, and occasionally psammomata (p 215) and secondary carcinomatous deposits. (iii) *Tuberculous foci* are met with either associated with or apart from any meningeal infiltration, varying in size con-

siderably, and may be either firm and caseous, or with a diffuent centre (iv) *Gummata* of the brain usually spring from the meninges, and are more irregular in shape than tuberculous masses (v) Occasionally *hydatid cysts* are found, as also other less common conditions

Cerebral tumours are more often observed in males than in females, and the different forms occur at varying periods of life Thus, glioma and sarcoma are most common at puberty or in middle life, tuberculous foci, in children, gummata, in the fourth or fifth decade, carcinomata, in middle or late life, and parasitic tumours in the second and third decades

The *local effects* of a cerebral tumour may be to cause some amount of sclerosis of the surrounding brain substance, whilst, if superficial, the membranes may become adherent and the overlying bone thickened

The **Symptoms** of a cerebral tumour can be classified as follows (1) Those due to increased intracranial pressure, such as fixed headache, giddiness, epilepsy, loss of memory, and stupor, finally ending in coma The headache varies much in character, but is usually localized, occurs in severe paroxysmal attacks, and is often associated with tenderness on deep pressure over the scalp It is increased by anything that causes passive congestion of the brain, such as coughing, and it is most important to note that the sites of the maximum pain and of the tumour often correspond Occasionally coma and a fatal issue supervene suddenly as a result of acute spreading oedema (p 771) (2) Vomiting and constipation are also very marked phenomena, associated with loss of appetite, foul breath, and great emaciation The vomiting bears no relation to the ingestion of food, and is not preceded by nausea It often develops concurrently with the pain, or may relieve it, and is most common in subtentorial tumours The temperature is usually subnormal, but if there is any basal meningitis it may be elevated (3) Optic neuritis is generally present, and is supposed to be due either to the increased intracranial pressure, causing obstruction to the return of blood from the eye to the cavernous sinus, or to a descending neuritis, or possibly to both In the early stages, the clear definition of the disc margin becomes obscured, and the retinal veins congested and tortuous, the retina is oedematous, so that the vessels are only seen at intervals and linear ecchymoses may also occur If the patient lives long enough, atrophy of the disc follows In the early stages vision may be but little affected, but, as a rule, it is considerably impaired towards the end In some cases this condition may be more marked on the side of the lesion, but is generally bilateral (4) Focal symptoms are of great value for localizing the lesion Irritative phenomena are first produced, and subsequently paralysis If the cortex of the motor area is involved, Jacksonian epilepsy often results, with an aura corresponding to the centre mainly affected, the convulsions spread in a regular order, and may involve the opposite side of the body and even produce unconsciousness At a later date localized paralysis may occur When the subcortical white

substance is the focal point, paralysis ensues early, apart from spasmodic phenomena. Affections of the functions of sensation, vision, speech, hearing, etc., are produced when other parts of the brain are involved, but we must refer students to text-books of medicine for a further consideration of these lesions. The surgeon is seldom called upon to make a diagnosis in these cases, and therefore the full details of this intricate subject will not be considered here.

**Treatment**—In every case, the possibility of the symptoms being due to gummatous disease must not be forgotten, and large and increasing doses of iodide of potassium (even up to 40 or 60 grains three or four times a day) should be administered before undertaking operative proceedings. Symptoms of gastric irritation must be prevented by giving some alkaline carbonate (especially the ammonium or soda salts), whilst the dose should be freely diluted with water.

**Operation**—It is most desirable that this should be undertaken as early as possible, since, even if no tumour exists, the patient runs but little serious risk, whilst delay until all the classical symptoms are well marked may prevent the total removal of the growth.

The scalp should be entirely shaved a day or two previously, and very thoroughly purified. A quarter of a grain of morphia is injected about half an hour before the operation, with the idea both of reducing the vascularity of the brain and of dulling the patient's sensations, so that a smaller amount of anæsthetic is subsequently needed. Chloroform should be employed rather than ether, as it produces less congestion of the head. The surgeon marks the supposed site of the growth on the skull with a bradawl through the scalp. A large semicircular flap is then turned down, exposing a considerable area of the calvarium, so that if a larger amount of bone than is expected needs to be removed, no fresh scalp incisions are required, moreover, the cicatrix will in this way be prevented from forming over the opening. One of the methods of opening the cranium already described (p. 763) is then employed, the further proceedings on the brain are carried out at once, or the intracranial portion of the procedure is delayed for a week or so. Under such circumstances the wound is re-opened, and the dura mater exposed.

The dura mater when laid bare under normal conditions is firm, but yields slightly to the finger, and allows the pulsation of the subjacent brain to be felt, if the latter is healthy and no undue pressure is present within, but if the intracranial tension is markedly increased, the dura mater bulges into the wound, feels firm and unresisting, and the cerebral pulsations are diminished or absent.

The dura mater is next incised crucially, or a flap turned down, care being taken to avoid, if possible, the meningeal vessels, the brain substance protrudes if the intracranial pressure is excessive. The region is gently explored by the finger, and any areas of abnormal hardness or softening noticed, failing this, a grooved needle is inserted in different directions, or a fine trocar and cannula. In introducing such instruments, care must be taken to make direct stabs, and never any lateral movements, which necessarily lead to

laceration of the brain The opening of the skull may be enlarged, if need be, either by the use of the bone rongeur or by additional small trephine holes It is but rarely that a cerebral tumour is so placed that enucleation is possible, it is estimated that not more than 10 per cent of all cerebral tumours are removeable If, however, a cortical neoplasm is found, it is isolated from the surrounding brain substance by blunt instruments, *e.g.*, the handle of a scalpel, or a flexible knife, made of platinum, as suggested by Horsley, and the mass freely removed Hæmorrhage is controlled by the application of fine ligatures, or by the use of serrefines, or by sponge pressure The dura mater is then loosely stitched together, and a drainage-tube inserted, reaching to the bottom of the wound, and brought out at one angle of the incision in the skin, which may be closed by a continuous suture If a small tumour, and presumably non-malignant, has been satisfactorily enucleated, the disc of bone may be replaced, room, however, being left for the passage of the tube, but if there is any doubt as to its complete removal, the opening in the bone is left After the operation, the patient must be kept absolutely quiet, with the head slightly raised The drainage-tube is removed in twenty-four or forty eight hours, and the scalp wound is usually healed in six or seven days

Even if the tumour is inaccessible or irremoveable, temporary benefit often results from an exploratory operation, since a subcutaneous hernia cerebri is thereby allowed to form, and intracranial tension relieved as evidenced by an improved mental condition and loss of pain, as the tumour grows, however, the patient relapses into his former state, and death follows sooner or later

### The Surgical Treatment of Epilepsy

It would be waste of time to discuss the many surgical procedures which have been suggested in this connection, *e.g.*, ligature of the carotid or vertebral arteries, total excision of the cervical sympathetic chain on each side, etc., mainly devised with the idea of modifying the cerebral circulation The only operation now seriously considered is that dealing directly with the cerebral cortex, a proceeding dependent on the supposition that the epileptic convulsion is a symptom, and not in itself a disease, and that it results from an irritable condition of the cortex, which may be excited into convulsive activity by various stimuli, originating either in the brain or elsewhere Sir Victor Horsley\* classifies epilepsy as follows

- (1) Idiopathic (with no gross lesion)
  - (a) Onset localized (focal)
  - (b) Onset generalized
- (2) Jacksonian (always some gross lesion or traumatism)
  - (a) Traumatic (with local or general convulsion)
  - (b) Congenital
  - (c) Neoplastic (tumour, abscess, aneurism)

\* *Trans Medical Society of London*, February 9 1903

(3) Reflex (injury of spine, nerves, etc )

(4) Hystero-epilepsy

As regards the characteristic symptoms and pathological phenomena found in many of these conditions, students must refer to medical text-books

Before discussing the individual groups from the surgical standpoint, one or two general considerations must be noted. In the first place, the prognosis is gravely modified by the length of time that the epileptic habit has persisted, and in traumatic cases if the affection has lasted two years the outlook is very unsatisfactory. A careful study should also be made of the family history as to the existence or not of a neurotic predisposition, in many cases of traumatic epilepsy this is well marked, and then the outlook is correspondingly bad.

It is now generally recognised that operation is useless in the idiopathic variety, even when the onset is accompanied by focal symptoms.

**Congenital epilepsy** is often more or less of the Jacksonian type, and usually depends on some injury sustained during birth. It is frequently associated with other evidences of cerebral mischief (spasm, paralysis, etc) and with defective growth. If taken early, and if the convulsions still remain localized, some good may follow operation, but if allowed to progress too far, the disease is irremediable by surgical means.

When due to *tumours*, *abscess*, etc, epilepsy is accompanied by other manifestations, which should guide the surgeon to a correct opinion as to the nature of the case and the operative outlook.

**Reflex epilepsy** is rare, and may perhaps be cured by dealing with the causation focus. As regards **hystero epilepsy**, the surgeon must never be tempted to undertake such a measure as double oophorectomy, which has been again and again tried and found wanting.

**Traumatic Epilepsy** is the term applied to an epileptic condition resulting from injuries. It may arise from any of the following conditions: (1) A neuralgic and irritable cicatrix in the scalp, (2) a slight unrelieved depression of the skull, (3) excessive formation of callus after a fissured fracture, or chronic thickening of the bone from osteitis after a contusion, whereby the dura mater is pressed upon and irritated, (4) chronic meningitis, usually associated with an adherent cicatrix in the brain, and particularly liable to occur in syphilitic patients, (5) a single depressed spicule of bone projecting into the cerebral substance.

The **Symptoms** produced are epileptic seizures of the Jacksonian type, the exact manifestations varying with the portion of cerebral cortex which is involved. Localization of the lesion depends partly on the character of the aura, partly on the associated symptoms, such as a fixed headache or the presence of a cicatrix. The convulsions are localized to begin with, but often become general.

**Operative Treatment** is only applicable in those cases in which the convulsions remain localized, general convulsions place the patient

in the category of idiopathic epileptics with a focal onset. The skull is opened over the site of the supposed injury, and it may be that some depressed fragment or spicule of bone may be found, it will, of course, be removed. If, however, nothing is found but an adherent cicatrix between the membranes and the underlying brain, it is still an open question as to whether the surgeon should proceed further. In a considerable number of cases the cicatrix and underlying brain substance have been removed, the fits ceased for a time, but in most instances recurrence followed sooner or later from the formation of a fresh adherent cicatrix. At the present time the surgeon should introduce a sheet of sterilized gold or silver foil between the brain substance and the membranes to prevent this occurrence. The locality of the lesion has a considerable influence, according to Horsley, on the result, since the prognosis is good in the motor area, middling in the sensory (parieto-occipital) region, and bad in the frontal. The obvious difficulty of dealing with epileptic conditions emphasizes the statements already made (p 756) as to the importance of dealing with all depressed fractures of the skull, simple or compound, slight or severe, by immediate operation, so as to prevent, as far as possible, the development of the mischief.

**Traumatic Insanity** is sometimes produced by slight depressions or lesions, similar in nature to those causing epilepsy, and can occasionally be relieved by operation. Certainly, when a distinct history of injury precedes the mental aberration, and when there is any localizing lesion or symptom, an exploratory operation is justifiable, and in a number of cases excellent results have followed. The type of insanity is not constant, but varies with the condition and environment of the individual.

### Hernia Cerebri

By *hernia cerebri* is meant a protrusion of the brain substance through an *acquired* opening in the skull. It thus differs from an *encephalocele*, which consists in the protrusion of brain substance, through some *congenital* defect.

It is always an evidence of increased intracranial pressure, and may be looked upon as Nature's safety-valve for the relief of compression. It is met with in two distinct forms.

- 1 When an opening has been made by the surgeon for the treatment of a cerebral tumour, which is subsequently found to be irremovable. The disc of bone is not replaced, and the brain substance protrudes through the opening under the scalp, by this means a temporary relief of intracranial tension is brought about, the patient's life prolonged and possibly consciousness for a time restored. The tumour, however, continues growing, and sooner or later the patient dies comatose.

- 2 The other variety, due to a compound depressed or punctured fracture, is the result of sepsis in the underlying brain substance, and the increased pressure within the skull thereby induced leads to a



protrusion of inflamed and œdematous brain matter through the wound in the dura, which is usually of small size. The tumour is soft and dusky in colour, and pulsates synchronously with the heart, the pulsations being often evident to the naked eye, and it usually increases in size somewhat rapidly. At first the mental condition of the patient is unimpaired, but sooner or later coma follows, if the hernia progresses, ending in the patient's death. To begin with, the mass consists mainly of œdematous granulation tissue covered by blood-clot, without much brain substance, but later on brain tissue itself may protrude. The condition is usually fatal, though recovery is occasionally seen. **Treatment**—Prevention of this affection must always be aimed at by endeavouring to render any wound involving the meninges aseptic and providing for drainage. Punctured wounds and depressed fractures of the skull, even when giving rise to no urgent symptoms, should always be operated upon, since free relief of tension may prevent the formation of a hernia cerebri, even should absolute asepsis not be attained. If, however, protrusion occurs, it may be possible in a few cases to apply a dry dressing and elastic pressure, and thus prevent it increasing in size, this, however, must not be attempted when the inflammatory symptoms are at all marked. In such cases it is of little use to slice off the tumour and apply pressure, and possibly the best treatment that has been suggested is to paint the projecting mass with absolute alcohol once or twice a day, it is an efficient antiseptic, and also tends by its dehydrating power to diminish the size of the hernia. If such treatment is successful, the tumour slowly granulates over and cicatrizes. Traumatic epilepsy may, however, ensue.

## CHAPTER XXVII

### AFFECTIONS OF THE LIPS AND JAWS

#### Affections of the Lips

**Hare lip** — By hare-lip is meant a congenital fissure of the upper lip, which may extend for a variable distance through the soft tissues alone, or may also implicate the bony alveolus and the floor of the

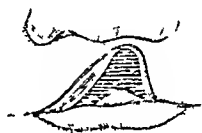


FIG 282 —SINGLE INCOMPLETE HARE LIP, INVOLVING MERELY THE TISSUES OF THE LIP AND NOT EXTENDING INTO THE NOSE

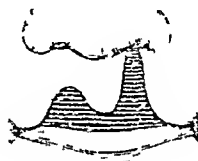
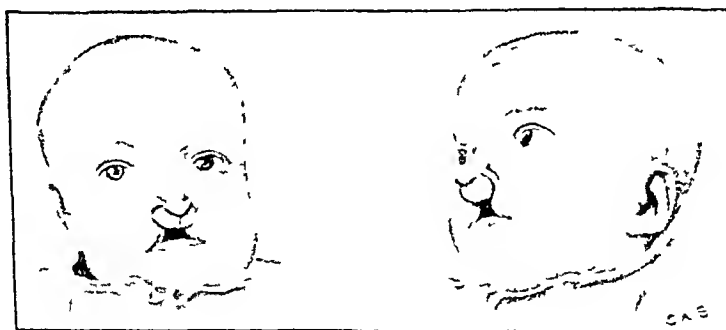


FIG 283 —DOUBLE HARE LIP COMPLETE ON THE LEFT SIDE, INCOMPLETE ON THE RIGHT



A

B

FIG 284 —DOUBLE COMPLETE HARE LIP, WITH DISPLACEMENT FORWARDS OF THE CENTRAL PORTION OF THE INTERMAXILLA (OS INCISIVUM)

A, Front view B, seen in profile

nose, and extend backwards through the palate. The name is not a good one, since a hare's lip is cleft in a Y-shaped manner, the fissure being central below, and bifurcating above into each nostril

**Varieties** — A hare-lip is complete or incomplete according to whether or not it extends into the nostril. It is simple if limited to the soft parts, alveolar, if the bony alveolus is also involved, complicated, if associated with a cleft palate. The defect may exist on one or both sides of the middle line, if unilateral or single, it is most common on the left side, in the proportion of two to one, if double or bilateral, it is usually, but not invariably, alveolar, and accompanied by a complete cleft of the palate. The central portions of the lip and alveolus (os incisivum) may either retain their normal position, or, as is more frequently the case in the bilateral type, project forwards at the end of the nose, forming a proboscis-like appendage (Fig 284, A and B). Even in simple cases the nose is deformed, being broad

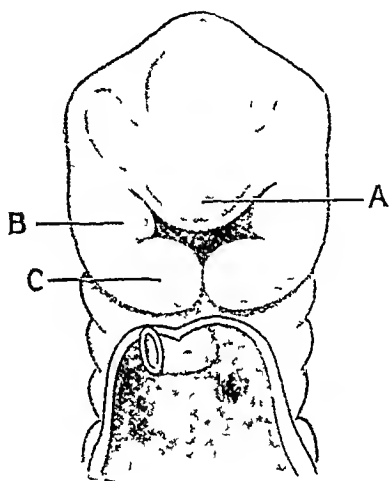


FIG 285 — HEAD OF FŒTUS OF ABOUT FIVE WEEKS, FROM VENTRAL ASPECT (AFTER HIS), SHOWING THE PRIMITIVE STOMODÆUM BOUNDED ABOVE BY (A) THE UNDIVIDED FRONTO-NASAL PROCESS, LATERALLY BY (B) THE MAXILLARY, AND BELOW BY (C) THE STILL SEPARATE MANDIBULAR PROCESSES

The quinque radiate appearance is well represented

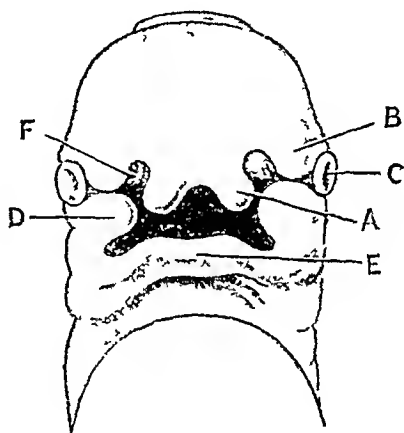


FIG 286 — HEAD OF FŒTUS OF SIX TO SEVEN WEEKS FROM THE VENTRAL ASPECT (AFTER HIS)

The mandibular processes (E) have now united the ocular vesicle (C) is seen on either side towards the upper end of the orbito nasal fissure, and the fronto nasal process has developed (A) internal and (B) external nasal processes on either side of (F) the still unclosed anterior nares

and flattened, a condition which becomes much more marked when the alveolus and floor of the nose are widely fissured. Hare-lip is not uncommonly associated with other deformities—*e g*, spina bifida and talipes—and it is frequently transmitted from one generation to another. Occasionally a thin red line, as of a cicatrix, is seen occupying the position of a hare lip cleft, and is probably due to a persistence of the raphe of union of the labial segments. A slight groove in the alveolus may also be observed at a corresponding point

**Development**—(For fuller details of the development of hare lip and cleft palate, we must refer readers to 'Hare lip and Cleft Palate' by W. Rose, Lewis and Co., 1891. Space only permits a very brief summary here.) The bony and fleshy parts of the face originate from the outgrowth of processes around the cavity formed by the bending forward of the primitive cerebral vesicle over the end of the notochord. At about five weeks after conception the primitive buccal cavity or stomodæum has a quinque-radiate appearance, due to the manner in which these processes are formed (Fig. 285). A broad median lappet (fronto-nasal process) descends from above, this is separated by a fissure on each side from the symmetrically placed maxillary processes, and these again below from the more prominent mandibular processes, which early unite across the middle line to form the lower jaw. The fronto-nasal process soon, however, changes,

developing four rounded buds, the relations of which are indicated in Fig. 286. On either side of a slight depression in the median line is placed the internal nasal process (A), from which are produced superficially the central portion of the upper lip and from its deeper aspect the inner segment of the intermaxilla (endognathion, Fig. 287, EG), carrying the central incisor. Separated from this by a hollow (F), which subsequently forms the anterior nares, is the rounded external nasal process (B), from which develop the side of the cheek, the ala nasi, and from its deep side the outer segment of the intermaxilla (mesognathion, MG) and probably the lateral incisor. External to this a fissure runs up to, and even beyond, the primitive eye (nasal orbital fissure), and this is later on closed by amalgamation of the internal and external nasal processes on the inner side with the adjacent maxillary process on the outer (D) except in the deepest part, which constitutes the nasal duct. The integrity of the upper lip is obtained by

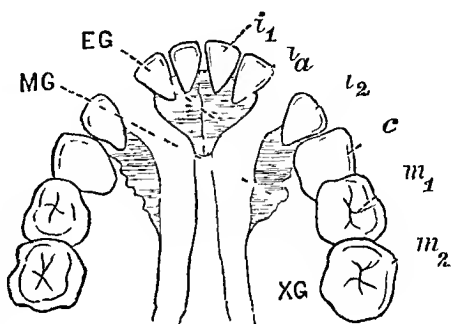


FIG. 287.—DIAGRAM TO REPRESENT THE ALBRECHT THEORY OF HARE-LIP SHOWING THE SITUATION OF THE CLEFT IN THE ALVEOLUS BETWEEN THE INNER AND OUTER SEGMENTS OF THE INTERMAXILLA.

EG, Endognathion, MG, mesognathion, XG, exognathion,  $i_1$ , central incisor,  $i_2$ , lateral incisor,  $c$ , canine,  $m_1$ ,  $m_2$ , first and second molars.

the union of the lower parts of the internal nasal and maxillary processes which thus exclude the external nasal from participation in its free border. It is doubtless owing to this arrangement that the sulcus or depression around the ala nasi constitutes such a distinct and characteristic feature of the face. At the same time the deeper parts of these nasal processes are uniting with one another and with the palatal plates which grow horizontally inwards from the under side of the maxillary processes uniting in a Y-shaped suture the point of junction of the limbs being situated at the anterior palatine canal. The union of all these elements is taking place from the sixth to the tenth week, and by that date even the whole the last part to unite should be complete.

Ordinary hare lip is due to a failure of union of the internal nasal process with the structures in external relation with it. If limited to the soft parts (simple hare lip), the cleft runs between the internal nasal and maxillary processes. If complete or alveolar between the same two below and superficially, but in addition between the internal and external nasal processes above and on the deep side. The cleft in the alveolus passes between the inner and outer segments of the intermaxilla (Fig. 287) and is thus bounded on the inner side by the central incisor, on the outer side by the lateral incisor. Occasionally two teeth are found growing from the endognathion the outer of the two being an accessory tooth whilst the lateral incisor and presumably the outer segment of the intermaxilla are often undeveloped or exist in a very rudimentary condition attached to the maxilla.

The os incisivum or projecting portion of the intermaxilla, consists of two segments of bone the two endognathia united in the median line and in a child contains two milk central incisors and the rudiments of the two permanent ones occasionally as we have just stated, there may be an accessory tooth developed on one or both sides of the process

A simple hare lip does not interfere seriously with the infant's nutrition, but when double, and especially if associated with a cleft palate, considerable trouble may arise, thus necessitating surgical treatment as a life-saving measure at a very early date. It must also be remembered that all movements of the face—*e.g.*, in crying or laughing—exaggerate the deformity from the unbalanced action of the divided orbicularis oris and other muscles

As to the *period* at which to operate, it is better to allow the infant to get over the shock of its entrance into the world and become acclimatized to an independent existence, whilst at the same time the operation should be performed before the troubles of dentition begin. From six weeks to three months is perhaps the best age for operation—in well-nourished and healthy children at the earlier date, in poorly-fed and weakly children at the later, unless the inanition is due to the difficulty of giving nutrition owing to the deformity. Under such circumstances the operation may have to be undertaken within the first three weeks

**Operation for Single Hare-lip**—The child should be laid on an operating table with its arms bound to the body. The surgeon stands behind it, the anæsthetist and assistant one on each side. The operation may be described in three stages

1 The *lip* is thoroughly *dissected up from the maxillæ* and alveoli by cutting through the reflections of mucous membrane and the attachment of the muscles and other soft parts. This is mainly needed on the outer side, and where there is much flattening of the nose the ala nasi will also require to be separated. This may cause some amount of bleeding, but sponge pressure easily controls it

2 The *edges of the cleft* are then *pared*. Many different methods have been employed to accomplish this, but it is only necessary to mention two. The object to be attained is the union of the cleft lip by means of a cicatrix, which shall be as unobtrusive as possible, whilst the red margin must be continuous, and the section such that the raw surfaces are larger than are absolutely necessary, so as to allow for subsequent cicatricial contraction without the development of a notch. The methods recommended are as follows

(a) The incision extends from the apex of the cleft, or from within the nostril, in a *crescentic* manner (Fig 288), so that a slight angular projection is formed to constitute a prolabium. This is done on each side, and where the nose is much flattened, more tissue is removed on the outer than on the inner side, so that when the parts are sutured together the nostrils become as nearly as possible symmetrical. By this means the depth of the lip is increased to allow of subsequent contraction, whilst the red margin can be made continuous

(b) *Mauclt's Operation* (Fig 289)—The inner margin and apex of

the cleft are pared, so as to leave a raw surface, a flap of red marginal tissue, as thick as possible, is then cut from the outer side, and implanted on the bevelled raw surface of the red margin on the inner side, the upper portions of the cleft being also apposed

3 *Sutures* are now inserted to maintain the lip in the position into

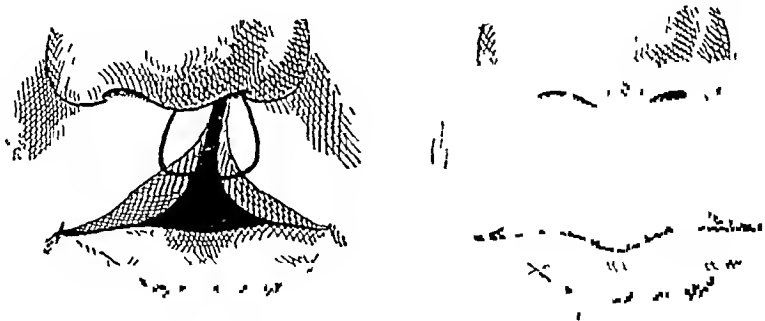


FIG 288 —ROSE'S OPERATION FOR SINGLE HARE-LIP

On the left side the semilunar incisions are seen extending as far as the free borders of the lip. The right hand figure shows the parts drawn into position, the wide cross lines represent the wire sutures, the narrow ones the catgut or horsehair stitches.

which it can be drawn by the fingers without tension. Two deep silver-wire sutures should be introduced, one just above the red margin, and one close to the nose, to draw into position and steady the nostril, which should be left smaller than that on the other side, so as to allow for subsequent dilatation, which is certain to occur.

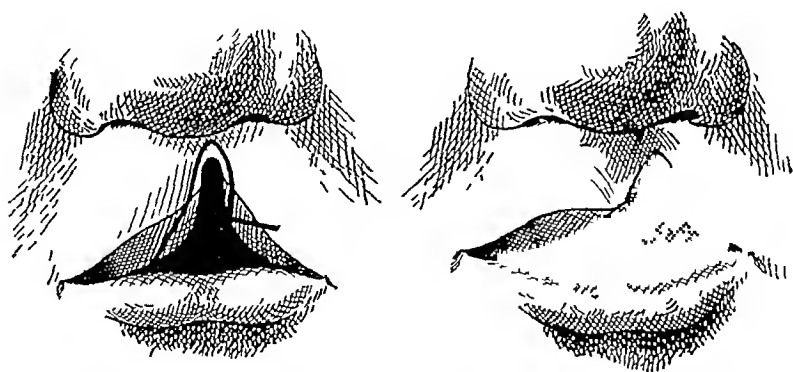


FIG 289 —MIRAULT'S OPERATION FOR HARE LIP

In the right hand figure the prolabial flap is shown ready to be implanted on the prepared inner side.

Horsehair or catgut stitches are used to bring the exact margins together, the continuity of the muco-cutaneous line being accurately preserved, and the cut edges of the mucous membrane upon the deeper aspect being sutured, each stitch, after it is tightened, being used to elevate and evert the lip and thus assist the insertion of the

next The wound is dressed with a small piece of gauze, and secured by another dry piece cut in the shape of a butterfly, so that the narrow body shall fit over the lip, and the wings spread over the cheeks, this is fixed by collodion, and maintained for some days after the stitches are removed, the deep ones on the fourth day, and the superficial ones about the eighth or tenth Careful feeding by the spoon is necessary, the mother's milk being drawn off and given in this way if possible In simple cases the child may be returned to the breast about the fifth day In order to prevent the child from picking at the lip or disturbing the dressing, it is well to put a splint on the flexor side of each arm to control the elbow-joint

The Treatment of Double Hair-Lip may be discussed under two headings, viz, the treatment of the os incisivum, and that of the soft parts

The os incisivum need not be touched if it retains its normal

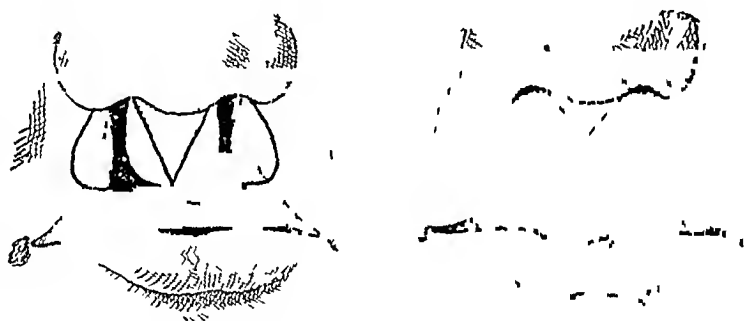


FIG 290 —ROSE'S OPERATION FOR DOUBLE HARE-LIP

The central tubercle is pared in a V shaped manner, and the lateral segments by curved incisions, extending to the red margin, and then inwards Only the apex of the central portion is included in the completed lip The long cross lines represent the position of the wire stitches, the shorter ones of the catgut sutures

position, and the labial clefts are then alone dealt with, but if it projects forwards, as is often the case, it must be either removed or replaced (a) In the former case the central portion of the upper lip is freed from it by dissection, and the base of the process divided with cutting-pliers, a small artery in the bone will spurt vigorously, and may need an application of the cautery to stop it The operation on the lip is deferred till ten days later (b) Reposition may be effected by several methods, the best of which is Bardeleben's, who incises the lower border of the septum, strips off the muco periosteum from either side, and then bends or breaks the bone back into position, fixing it by silver wires, and uniting the lip at once to form a splint to maintain it *in situ* The advantages claimed for reposition are that the patient retains his own central incisor teeth, and that the normal contour of the jaw and face is not interfered with Against this plan, however, must be placed the facts that the bone rarely becomes firmly united, that the teeth are stunted and erupt obliquely back-

wards from rotation of the process, and that its presence prevents the maxillæ from falling together and increases the difficulties of subsequently closing the palatal cleft. Personally we recommend extirpation in bad cases, since the disfigurement can to a large measure be removed by adding a projecting cheek-plate to that which carries the artificial incisors, thus pushing the upper lip forwards. (c) Where, however, the projection is not great, it is possible to diminish the size of the os incisivum by gouging away the teeth contained within it, so that the lip can be closed over it.

The soft parts of the lip are dealt with in much the same way as in single hare-lip. They are freely detached from the maxillæ, and the edges pared, as shown in Fig 290, the central portion being cut into a V, and no attempt made to incorporate it into the free margin for fear of depressing the tip of the nose, whilst the lateral segments are pared as in the single operation. These latter are now drawn together and united in the middle line below the central portion, so that a Y-shaped cicatrix results. One of the deep silver stitches should fix the apex of the V, the other should be inserted just above the red margin. The dressing and after-treatment are as in the single operation. For a time the child may have difficulty in breathing owing to the diminution in the size of the oral aperture, but this is obviated by the nurse drawing down the lower lip with the fingers, or by painting it in a vertical direction with collodion.

Other congenital abnormalities of the lip are met with, which, however, can only be briefly mentioned here.

**Median Hare-lip** may occur in one of two forms: either a simple cleft exists in the middle line (Fig 291), or there may be an absence of the intermaxilla and nasal septum, causing flattening of the bridge of the nose, and a broad median defect, flanked by the maxillary portions of the lip.

**Oblique Facial Cleft** is an uncommon deformity, characterized by a cleft or sulcus in the face starting from the usual situation of a hare-lip below, but running up outside the nostril to the inner side of the lower lid (Fig 292).

**Coloboma** of the iris or choroid is sometimes associated with this rare defect. The deformity is due to non closure of the naso orbital fissure and runs along the line of the nasal duct. It may be limited to the soft parts or may involve the bones even laying open the antrum.

**Macrostoma** (Fig 293) is characterized by an abnormal width of the mouth, and is due to non-union of the maxillary and mandibular processes. It may be uni or bi lateral, and is usually associated with anomalies of development of the ear, accessory auricles being often present. As a rule, a small papilla on the upper and lower margins will indicate the true limits of the mouth being constituted by the points of attachment of the orbicularis. The existence of these is of great importance as indicating the extent to which the cleft must be pared in order to restore the mouth to its normal size.

**Mandibular Clefts** are exceedingly rare. They are due to non union of the mandibular processes in the middle line, and involve either the soft tissues of the



FIG 291 —MEDIAN HARE LIP.  
(PITTS' CASE)



lower lip alone, or may extend to the bone, and even the tongue Treatment is as for ordinary hare-lip

**Microstoma** is the term applied to a condition in which the fusion of the parts entering into the formation of the lips progresses to a greater extent than usual, so that the oral orifice is contracted It may be associated with defective development of the lower jaw In the more severe cases, where the mouth is extremely narrowed, a transverse cut should be made outwards on each side, and the mucous membrane stitched to the skin

**Macrocheilia**, or hypertrophy of the lip, occurs in three forms  
1 The congenital variety, a condition analogous to macroglossia, and due to a congenital distension of the lymphatic spaces, or chronic lymphangiectasis, accompanied by overgrowth of the connective tissue The lower lip is most often involved, and is firm, thickened,



FIG 292 —OBLIQUE FACIAL CLEFT OR, RATHER, CICATRICIAL DEFORMITY ALONG THE LINE USUALLY TRAVERSED BY SUCH A CLEFT (KRASKE'S CASE)



FIG 293 —MACROSTOMA WITH AURICULAR APPENDAGES (FERGUSSON)

and everted, causing considerable deformity The treatment consists in the removal of a V-shaped portion from the centre 2 An acquired form occurs in children and young people with a tuberculous inheritance, constituting the so called 'strumous lip' Either lip may be affected, but perhaps more frequently the upper, the thickening is due to a chronic lymphangitis, resulting from the absorption of septic material from persistent cracks and fissures If these can be healed, and the general health improved, diminution in the size of the lip soon follows 3 In adults, macrocheilia is in almost all cases due to tertiary syphilis The lower lip is most often enlarged, and becomes thick and hard It is due to the diffuse sclerosis characteristic of tertiary mischief General treatment, and not local, is needed

**Syphilitic Affections of the lip** are not uncommon A *primary*

chancre may be caused by kissing, or by smoking an infected pipe, or drinking from a glass with an infected rim. It usually presents a smooth ulcerated surface, discharging a small amount of sero-pus, resting on a mass of infiltrated tissue which may extend over the whole lip (Fig 294). The induration is not so great as in chancres upon the genital organs, but the infiltration is much more extensive. An indolent enlargement of one or more of the submaxillary lymphatic glands occurs very early, and the disease usually runs an acute course. Ordinary specific treatment is all that is needed. A labial chancre may closely resemble epithelioma, but is distinguished from it by its rapid development up to a certain point, by the early implication of the glands, which soon become very large, by the absence of typical cachexia, by the age of the patient, and the course taken by the case, as well as by the local appearances. The surface is usually flattened, and less warty and irregular than in epithelioma, whilst the skin is more involved than the mucous membrane. Should the chancre have existed for any time, the presence of a rash or sore throat may materially assist in forming a diagnosis. Moreover, it is said to be more common on the upper lip, whilst epithelioma is usually seen on the lower (compare Figs 294, 295). In the *secondary* stage mucous tubercles are frequently met with, involving the inner side of the lip and the angle of the mouth. In the *tertiary* period serpiginous ulceration and gummata may occur, or the diffuse induration described above. In *inherited* syphilis, cracks and mucous tubercles are constantly present, and may be so extensive as to leave cicatrices radiating from the mouth, which are very characteristic (Fig 21).

**Cracked Lips** (or, as they are often called, *chapped lips*) are usually the result of cold weather, a central crack or fissure forming which is extremely painful, and liable to bleed very readily on everting or stretching the part. The lower lip is that generally affected. In tuberculous children more than one may occur, and by their persistence they give rise to a considerable degree of induration and infiltration, and perhaps lead to glandular trouble. All that is needed in the shape of *treatment* is the application of a little lanoline or cold cream, but if they persist, it may be advisable to touch them with nitrate of silver.



FIG 294 —CHANCRE OF UPPER LIP  
(FROM A PHOTOGRAPH)

The enlargement of the submaxillary lymphatic glands is very evident

**Herpes Labialis** is a condition usually associated with catarrh, and not unfrequently with pneumonia or other fevers. Either lip may be affected, and the herpetic eruption is quite limited in extent. It consists of a number of little vesicles situated on a hyperæmic and painful base, after a few days the vesicles become transformed into pustules, and these in turn burst and dry up, the whole affection lasting perhaps a week or ten days. No special treatment is required. If the inner aspect of the lip is affected, the epithelium early becomes sodden and is shed, so that the vesicular stage is much shorter.



FIG 295.—CHRONIC EPITHELIOMA OF LOWER LIP (FROM A PHOTOGRAPH)

**Mucous Cysts** occur on the inner side of the lip in the form of small rounded swellings, which are translucent and contain a glairy fluid. They are often due to trauma, whereby the opening of a mucous gland is blocked. The whole cyst wall should be dissected out, and the wound closed by stitches.

**Nævi** are frequently met with in the lip. If confined to the inner aspect they may be dissected out, but when large and involving the whole thickness, they should be dealt with by electrolysis.

**Warty Growths** are often seen on the lower lip, especially near the angle, and may then simulate epithelioma. They are distinguished, however, by the

fact that ulceration is not often present, that the lymphatic glands are not involved, and that there is but little infiltration of the base. They should, however, be removed as early as possible, since malignant disease often starts from them.

**Epithelioma** of the lip usually occurs in men of the working classes, and is commonly stated to be due to the irritation produced by smoking a short clay pipe, which is allowed to rest on one or the other side near the angle. A semicircular notch will frequently be noticed in the teeth of the upper and lower jaw, corresponding to the situation of the growth on the lip, and caused by the constant friction of the pipe-stem. It may also start opposite the site of some projecting rough or carious tooth. It is but rarely met with in women, occurring in England in not more than 5 to 6 per cent of the cases, and of these, according to Hutchinson, half are clay-pipe

smokers It is also more common amongst country folk who use the short clay pipe than amongst the cigarette and cigar smokers in towns

The disease may start as an induration around a crack or fissure, which gradually extends, forming a typical malignant ulcer, or as a wart-like growth, which fungates and ulcerates, or as a chronic infiltration leading to an irregular nodulated thickening of the lip, which sometimes looks shrunken and feels sclerosed (Fig 295)

If allowed to run its course unchecked by treatment, the disease steadily progresses, forming an ulcerated mass of greater or less size, and even involving the jaw. The submental and submaxillary glands are early implicated, and secondary deposits are also found in the glands which accompany the carotid vessels Beyond this, however, the disease rarely extends, visceral complications being uncommon When a fatal issue results, it is generally caused by the secondary growths in the neck, which attain considerable dimensions and then ulcerate, this stage being possibly preceded by one of cystic degeneration From these ulcerating surfaces a variable amount of



FIG 296 —V-SHAPED INCISION FOR REMOVAL OF EPITHELIOMA OF LIP

discharge escapes, varying with the septicity or not of the wounds Hæmorrhage is also likely to follow from erosion of some of the vessels in the neck

The **Diagnosis** of epithelioma is rarely doubtful, but occasionally warty growths, or even a primary chancre (p 805), may be mistaken for it The clinical history generally suffices to determine the nature of the mass, as also the character of the base and the appearance of the parts, but in uncertain cases the removal of a small portion under cocaine, and its microscopic examination, are required to set doubts at rest

**Treatment**—The primary growth must be excised completely, if such be possible, and the submental and submaxillary region thoroughly cleared of lymphatic glands, whether they can be felt enlarged or not When once the deeper glands in the neck have been attacked, they often contract such adhesions as to render their extirpation impracticable

If the growth is limited to one part of the lip, a V-shaped wedge extending half an inch beyond it in all directions may be taken away (Fig 296), and the wound closed, as in a case of hare-lip, without much deformity resulting When it is more extensive considerable ingenuity must be exercised in order to make good the defect One

plan that often gives good results is to excise the growth by a somewhat larger V-shaped incision, and then to extend the labial fissure transversely to one or the other side, or to both, dissecting up these segments from the bone, the flaps can then usually be brought together, whilst the mucous membrane is united to the skin along the margin of the new lip

When the whole lower lip requires removal, *Syme's operation* may be performed with advantage. It consists first of all in the complete excision of the diseased lip. Two curved incisions are then made, starting from the middle line of the wound, and extending downwards under the chin, to terminate below the angles of the jaw, an inverted V-shaped portion of skin between them remaining fixed to the symphysis menti to form a base of support for the new lip. The lateral flaps are now dissected up, raised, and united one to the other in the middle line, so as to constitute the new lip, an inverted Y-shaped cicatrix resulting. The elasticity of the skin in this region allows this to be accomplished, and the whole wound closed, without leaving any part to granulate. The mucous membrane should be finally stitched to the skin over the upper free margin. Healing by first intention usually follows.

If the whole of the upper lip needs to be removed, it may be restored in a variety of ways. Perhaps one of the best consists in making incisions which skirt the alæ nasi on each side, and then extend outwards into the cheeks sufficiently to allow the tissues, when they have been freed from the maxillæ by undercutting, to be drawn together in the middle line. In such cases care must be taken not to encroach on Stenson's duct.

### The Extraction of Teeth

Although this operation is usually undertaken by dentists, yet surgeons and medical practitioners have occasionally to perform it, and not a little skill and judgment are sometimes required in its execution. An anæsthetic may or may not be required. If merely one or two teeth are to be drawn, gas or chloride of ethyl will suffice, but when a large number require extraction at one sitting, it is better to give ether or the A C E mixture, chloroform should never be employed when the patient is in the sitting position. The posterior teeth are, of course, dealt with first, and subsequently those in front. Suitable forceps are required for the various teeth, and the number of fangs belonging to each must be kept in mind. Incisor and canine teeth are removed by a combination of traction and rotation, the bicuspid and molars by traction combined with lateral movement, especially inwards. The forceps, after being sterilized, must be applied to the neck of the tooth well up under the gum, and no traction should be made until a firm grasp has been taken, and the tooth has been loosened by lateral swaying.

*Accidents* of various types happen from time to time. The crown may break away leaving the fangs *in situ*, and then each of these

must be sought with root forceps and accounted for. In dealing with the first or second upper molar, it is quite possible to drive a fang upwards into the antral cavity, setting up thereby acute suppuration within the cavity. Laceration of the gum is often unavoidable, and injury to the alveolar margin may follow, but such accidents as fracture of the lower jaw or dislocation of the temporo-maxillary joint are certainly avoidable. The use of an elevator is sometimes desirable in order to remove old roots, but it is an instrument that must be used with great care.

After extraction the mouth is washed out with sterilized or carbolyzed water, and the bleeding usually ceases without delay. If the gum has been much torn, it should be pressed back into position by the fingers, and when the mouth is septic, it may be desirable to touch the socket over with tincture of iodine. A mouth-wash of boric acid or sanitas is subsequently employed.

Should the *hæmorrhage* continue, as in patients suffering from purpura, scurvy, and hæmophilia, the socket must be carefully plugged with a strip of gauze soaked in a styptic, such as adrenalin or cocaine, the use of perchloride of iron in this connection is undesirable. Occasionally the bleeding re-starts after two or three days, and is then due to septic contamination of the alveolus, in such cases it is usually necessary to open up the socket freely from the outer side, cutting away gum and, if need be, bone, so as to allow free exit to discharges and a more ready access for strips of gauze soaked in styptics or antiseptics.

### Affections of the Gums and Alveolar Processes

**Spongy Gums** are not unfrequently met with as a result of the administration of mercury, or from scurvy. They are characterized by being soft and congested, bleeding readily on pressure, and perhaps showing signs of ulceration. All that is necessary is the correction of the determining cause and the use of an alum mouth-wash.

**Alveolar Abscess** (Fig 297) is almost always associated with suppuration around the fang of a carious tooth. The alveolar walls become expanded, and the pus finds its way over the edge of the bone (C, D), or even through the osseous tissue (A), under the external periosteum. If limited in extent, it perforates the gum directly, and is then known as a gum-boil, but it occasionally burrows beneath the periosteum, which is stripped from the bone, and may thus lead to an abscess of larger size, possibly resulting in necrosis of the jaw. The formation of an alveolar abscess is almost always associated with a considerable amount of pain of a very irritating nature, and when extensive may give rise to serious constitutional disturbance. Occasionally graver complications ensue, thus, in the upper jaw the antrum may be opened, and suppuration in this cavity follow, whilst in the lower the abscess may travel downwards and burst externally, either close to the lower margin of the bone or in the neck. A troublesome sinus results, which can only be cured by the removal

of the tooth, and even then a depressed and adherent cicatrix ensues, which is very unsightly. The most essential point in the *treatment* necessarily consists in the removal of the offending tooth. Often this is quite sufficient, and possibly the tooth may come away with an abscess cavity attached to one of the fangs. When suppuration occurs beneath the periosteum, the pain can at first be relieved in measure by fomentations, but as soon as fluctuation is detected an incision should be made through the mucous membrane, and the cavity emptied. Possibly it may be wise to keep a small piece of stuffing in for a few hours, but if a large enough opening has been made, all that is subsequently required is repeated and frequent irrigation, preferably with peroxide of hydrogen. If a small sinus

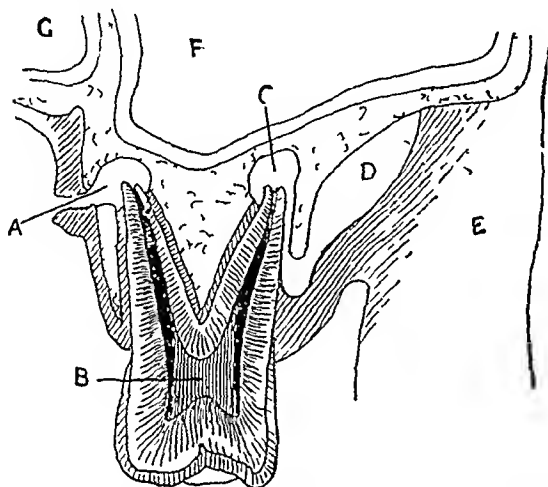


FIG 297 —DIAGRAM OF ALVEOLAR ABSCESS RESULTING FROM DISEASE OF MOLAR TOOTH (AFTER THE AMERICAN SYSTEM OF DENTISTRY)

- A, Abscess arising from escape of septic material from B the pulp chamber, through the foramen at apex of the fang it has burrowed directly through the alveolar process and burst through the gum. C similar abscess which has tracked down between the tooth and the alveolus, and spread out beneath the alveolar periosteum at D, constituting the typical alveolar abscess, E, cheek, F, antrum, G, nasal cavity

persists after removal of the tooth, it must be opened up, and any carious or necrosed bone removed.

**Pyorrhœa Alveolaris** (or **Riggs' Disease**) consists in an inflammatory condition of the margins of the gums, accompanied by a muco purulent discharge, which arises from pockets or pouches which may extend a greater or less distance along the roots of the teeth. In consequence of this the tissues of the gums shrink, and, together with the alveolar border, become atrophic, the fangs are thereby uncovered and the teeth loosened, so that after a while a natural cure is established by the patient becoming edentulous. The process is limited to a few teeth, or may involve many. It is always preceded by an excessive deposit of tartar, beneath which bacterial infection

occurs, the inflammation spreading down along the periodontal membrane. *Treatment* consists in the removal of the tartar and the application of astringents and antiseptics, preferably peroxide of hydrogen, not only to the exposed mucous membrane, but also into the pouches and pockets where pus collects. Treatment is often prolonged and tedious, but must be persisted in, not only to save the teeth, if possible, but also to prevent or remedy the toxæmic and dyspeptic symptoms which are due to the absorption of pus. In many cases, however, the teeth have to be sacrificed.

We desire here to emphasize strongly the importance of dealing effectively with all sources of *oral sepsis*, as also of similar conditions involving the nose and its accessory sinuses. Not only are such lesions locally dangerous, but the constant absorption of toxic material leads to various types of anæmia (including the pernicious variety) and to some forms of neuritis, it is also conceivable that the infection of the upper part of the digestive tract with virulent organisms may explain the origin of gastric ulcers, and possibly also of appendicitis.

**Hypertrophy of the Gums** is met with in the form of a sessile overgrowth, sometimes almost cauliflower-like, around and between the teeth, which are usually carious, it occurs most frequently in children, but occasionally in older subjects. In slight cases the overgrowth may be destroyed by the application of a crystal of trichloroacetic acid, but in the more exaggerated types excision is required.

**Dental Cysts** are by no means uncommon, resulting from the irritative effects of dental caries, hence they follow the distribution of that affection, and are most frequently seen in connection with the upper first molars and bicuspid. They develop at the roots of the teeth, causing a painless regular expansion of the bone, free from inflammatory phenomena, unless infected secondarily with bacteria. After a time the centre of the swelling softens, and, as the bony wall is absorbed, parchment-like crackling can be felt, finally, the condition presents as a rounded tense elastic swelling, around the margins of which the remains of the expanded bone can be detected. In the upper jaw they often encroach on and project into the antral cavity, but are not connected with it. The tooth which is the cause of the trouble is always dead, and frequently merely a septic root is present.

The *cause* of these cysts is probably the proliferation of certain embryonic remains of the enamel organ, brought about by the irritation of septic matter which has escaped from the pulp cavity. These foetal residues are lighted up into activity, develop into masses or cylinders of epithelial tissue, and then undergo cystic degeneration. Their pathogenesis is practically identical with that of the epithelial odontome, but merely one cyst develops here instead of many. The fluid contained therein is thick and mucoid in character, and broken-down epithelial cells and cholesterine are seen in it on microscopical examination.

**Treatment**—The cyst must be laid freely open into the mouth, the septic tooth or stump removed, and the anterior wall of its alveolus



cut away The alveolus and cyst thus laid into one cavity are scraped so as to remove all the epithelial lining, and packed with gauze so as to ensure healing by granulation In the upper jaw the utmost gentleness is required in dealing with the deeper wall of the cyst, as the septum between it and the antrum may be extremely thin and entirely devoid of bony tissue

**Epulis**—By this term is meant a tumour growing from the alveolar periosteum Two varieties are described, viz, the simple and the malignant

A **Simple Epulis** is usually of a fibromatous nature, and may grow from either jaw, though more commonly from the lower It is

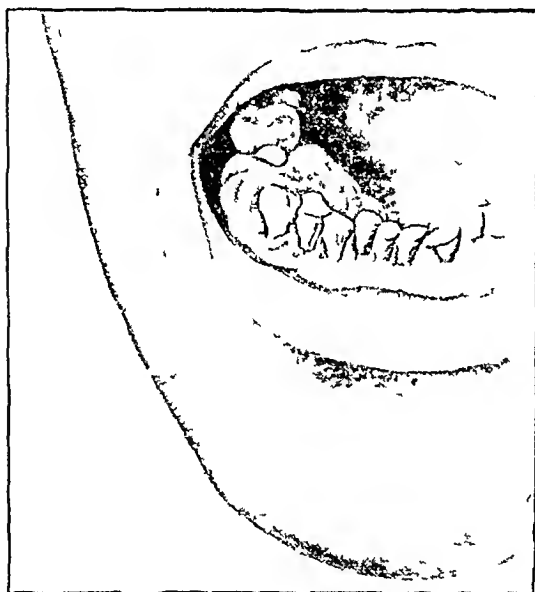


FIG 298—SIMPLE EPULIS

generally due to the irritation of diseased teeth, and although most marked on the outer aspect, it burrows between the teeth, and is also found on the inner side It appears as a red fleshy mass, smooth, or perhaps lobulated (Fig 298), of an elastic consistency, and possibly associated with a little superficial ulceration It is covered with mucous membrane, and may contain a few spicules of bone The *treatment* consists in removing the growth together with the teeth or stumps with which it

is connected If small, it will suffice to cut away and scrape the bone from which it arises, but if large, or if it recurs after such treatment, the portion of the alveolus from which it springs must also be excised This is best accomplished by extracting a tooth on either side of the tumour, and cutting vertically through each socket with a saw, the two incisions being united below with a chisel, so as to remove a quadrangular portion of bone without interfering with the continuity of the jaw

**Malignant Epulis**—This title is applied to a myeloid sarcoma growing from the medullary substance of the alveolar process It forms a soft rapidly-increasing mass of a dusky purple colour, which runs on to ulceration or fungation The deeper portions of the growth may contain an ossific deposit As with all forms of myeloid growth, it is only locally malignant *Treatment* consists in free removal of the mass and of the portion of alveolus from which it

arises In the upper jaw this sometimes necessitates excision of the complete palatal segment of the maxilla, but in the lower jaw it is generally possible to maintain the continuity of the mandible by removing merely a quadrilateral portion in the same way as for a simple epulis

**Epithelioma and Sarcoma** (round or spindle-celled), arising from the gum, are both occasionally met with Epithelioma in this situation rarely fungates, but rather tends to invade the bony tissues, and in the upper jaw extends upwards to the antrum, hence it is sometimes termed a 'creeping or burrowing epithelioma' The ordinary signs of this disease become evident, lymphatic glands are enlarged, and typical ulceration of the gum follows The only possible *treatment* consists in free excision of the growth, together with the portion of bone affected

**Necrosis of the Jaw** — **Causes** (1) Subperiosteal alveolar abscess, connected with dental caries (2) Traumatism, such as blows on the jaw, with or without fracture, in the latter instance being due to septic periostitis or osteo-myelitis, owing to the lesion becoming compound The use of dirty forceps or elevators in extracting a tooth may similarly light up an infective inflammation, resulting in necrosis (3) In tertiary syphilis necrosis also occurs, affecting most frequently the palate or alveolar borders (4) It occasionally results from mercurial poisoning, but rarely at the present day (5) Phosphorus necrosis is met with amongst those who work in lucifer-match factories, but only when ordinary phosphorus is used, the amorphous form is harmless The fumes are supposed to gain access to the jaws through carious teeth, giving rise to a somewhat acute inflammation, which terminates in necrosis A considerable amount of new bone forms beneath the periosteum, and the sequestrum, which is curiously gray and porous, like dirty pumice-stone, is always slow in separating Either jaw may be affected, but perhaps the lower a little more commonly than the upper (6) Necrosis may follow one of the exanthemata, arising as an infective idiopathic or embolic osteo-myelitis, and then probably affecting a considerable extent of bony tissue, possibly the whole mandible (7) Tubercle is occasionally responsible for this condition

The symphysis menti in children is occasionally the seat of a pyogenic or tuberculous infection, previous to the eruption of the permanent incisors An abscess forms, and caries, or a limited necrosis results In a case of this type an opening is required in the submental region, through which the diseased tissue can be thoroughly scraped away The teeth are of course lost, but a good result, and with but little scarring, may be anticipated

The **Clinical Phenomena** associated with necrosis of the jaw are necessarily much the same whatever the cause The acute form commences with severe pain in and around the jaw, followed by great swelling of the face and difficulty in opening the mouth or taking food The temperature is raised, and even rigors may be present, the breath is usually foul Sooner or later an abscess forms, which may point either in the mouth or on the face, or the pus may burrow downwards for some distance into the neck Sinuses persist,

discharging the most offensive pus, a new case of bone sometimes forms in the lower jaw, enclosing the sequestrum, but in the upper this is rarely noticed, and even in the lower it is not unusual to see a considerable amount of bare or dead bone absorbed without the formation of an involucrum

**Treatment** —In the early stage the mouth should be fomented, and as soon as there is any suspicion of pus a free incision is made down to and along the bone. When necrosis is present, it must be treated in the ordinary way, the sinuses being flushed out with an antiseptic solution three or four times a day until the sequestrum is loose, it is then removed, if possible, from within the mouth. Drainage by means of an external opening is often absolutely necessary. In the worst cases necrosis may extend from the middle line of the mandible to the temporo-maxillary articulation, it is then wise to make an external incision, and remove the bone *in toto* after detaching it by saw from the other ramus.

### Affections of the Antrum

**Suppuration within the Antrum** (*empyema of maxillary sinus*) frequently arises from disease connected with the fangs of the first or second molar or bicuspid teeth, it not uncommonly extends from the nasal cavities in connection with disease of the middle turbinate bone, or may be secondary to suppuration within the frontal sinus, it is occasionally lighted up by injury. In chronic cases it is not unusual to find the antrum filled with soft polypi.

The **Symptoms** produced are often extremely equivocal, and the condition may be present for some time without being recognised. In the *chronic* forms all that is noticed may be an intermittent discharge of pus into and from one side of the nose, associated perhaps with some pain in the infra-orbital region, a chronic cough, and an irritable throat. The pus varies considerably in amount and character, being sometimes extremely offensive. On holding the patient's head forwards, it can be demonstrated that there is an overflow of pus into the nostril, and sometimes when the patient reclines it flows back into the pharynx. Should the opening into the nose become blocked, all the symptoms are aggravated, the pain becoming more marked and the swelling increasing. *Signs of distension* of the cavity may also be produced in this way, such are manifested in four directions. (*a*) Inwards, causing obstruction to nasal respiration, and possibly epiphora, from compression of the nasal duct, (*b*) upwards, leading to protrusion of the eyeball or exophthalmos, (*c*) downwards, resulting in depression of the side of the palate, and possibly irregularity in the line of the teeth, and (*d*) outwards, giving rise to a somewhat characteristic projection of the cheek beneath the malar eminence. Under these circumstances, a finger inserted into the mouth, between the cheek and the bone, will detect a loss of resistance in the anterior wall of the antrum, and if the distension has lasted long, eggshell-crackling may be noticed, or the whole anterior wall

may be absorbed and an elastic swelling take its place. Infra-orbital neuralgia is often a marked feature in these cases.

In *acute* cases all the above phenomena may be present in an accentuated degree, accompanied by severe tensive pain and some amount of febrile disturbance. Necrosis of the lining bony walls may also be induced, owing to the fact that the mucous membrane is closely adherent to the periosteum.

The **Diagnosis** of suppuration within the antrum is not always easy. The periodic discharge of pus from the nose is suggestive, as also the presence of a dead or painful molar or bicuspid tooth. If a flow of pus can be induced by change of position of the head, it is pathognomonic of suppuration within one of the accessory sinuses connected with the nose, probably of the antrum. If, after the nose has been cleared and the head hung down, pus is seen welling up from under the middle turbinal, the diagnosis is almost certain. *Transillumination of the antrum* may confirm this opinion. A small electric lamp is placed within the mouth, and if the patient is in a dark room, and his antra are normal, the cheeks, lips, and lower margins of the orbits become of a rosy-red colour. If, however, the cavities are occupied by pus, blood, or a growth, the parts remain dark. Transillumination does not answer in every individual, and hence the value of the test is much diminished. The presence of illumination excludes intra-antral growths or abscess, but its absence, unless unilateral, is not of much significance. Finally, the antrum may be punctured with trocar and cannula through the canine fossa, and an absolute diagnosis obtained.

The **Treatment** necessarily varies with the type of the disease. In the early active form that sometimes follows the extraction of a tooth, and may even be associated with the pushing up of a broken fang into the cavity, it will probably suffice to enlarge the opening in the alveolus with a suitable antrum drill. A solid rubber plug is introduced, and the cavity washed out into the nose with sterile salt solution two or three times a day, until the purulent discharge ceases, when the opening may be allowed to granulate. The solid plug is better than a hollow tube, which permits discharge to get into the mouth, and food or septic material to pass into the nose.

In the more chronic cases, when the mucous membrane is thickened and infiltrated, and possibly polypi are present, a more extensive procedure is required. The antrum is opened by gouging through its anterior wall above the first molar after dividing the mucous membrane. If this tooth is present, it may advisably be drawn, and the anterior wall of its socket cut or gouged away. A sufficient opening must be made for the admission of the finger, so as to allow the interior of the cavity to be thoroughly explored and curetted. It is also important to deal with any intranasal mischief that is present, and if need be the anterior half of the middle turbinal must be removed so as to give a free exit into the nose for discharge, and to permit of thorough irrigation. It is sometimes possible to close the

incision in the mouth, the antrum being washed out from the nose, but in old-standing cases it is often necessary to pack the cavity with gauze from the mouth, and make it heal by granulation. After a while the opening into the mouth contracts so as to allow of the introduction of a solid metal or rubber plug fitted to a tooth-plate, which can be gradually reduced in size so as to allow the sinus to heal.

**Hydrops Antri** is the term applied to a chronic distension of the antrum with a glairy mucoid fluid, somewhat similar in character to that contained in a ranula. The condition is painless, and free from inflammatory phenomena, and as the expansion increases, eggshell-crackling of the anterior wall, or even distinct fluctuation, may be observed. It was formerly supposed to arise from obstruction to the aperture into the nose and retention of secretion, but is in reality due to a cystic tumour-forming from the glands of the mucous membrane, or more often to a dental-cyst (p 811) which has encroached on the antral cavity. The *treatment* required is to open thoroughly the cyst from the mouth after dividing the mucous membrane, subsequently removing a sufficient portion of the anterior wall to enable it to be washed out and drained. It is sometimes possible to do this without wounding the lining membrane of the antrum.

Various **Tumours** may originate in the antrum, *e.g.*, mucous polypi, fibromata, odontomata, osteomata, sarcomata, and cancers. If limited to the cavity, they produce no definite symptoms, except when large enough to cause expansion of its walls. Malignant growths, however, usually pass beyond the limits of the antrum, and lead to the usual signs of malignant disease of the upper jaw. *Treatment* consists in removing simple growths, if possible, without interfering with the integrity of the maxilla. This may be accomplished by reflecting the overlying cheek, as in excision of the upper jaw. For malignant tumours, removal of the whole bone is the only possible remedy.

### Tumours of the Upper Jaw

Many of the **Simple Tumours** springing from the upper jaw have been already described amongst those involving the alveolar border and antrum. Only a few remain to be dealt with.

**Osteoma** occurs either in the form of a tumour composed of compact tissue, then usually growing within the antrum, or it is occasionally met with as a diffuse symmetrical overgrowth, constituting the condition known as *leontiasis ossea*. A few cases of **Chondroma** have also been reported.

By **Leontiasis Ossea** is meant a disease, fortunately very rare, characterized by the formation of diffuse hyperostoses from either the cranial or facial bones, or from both. It usually commences in young adult life, and both rickets and syphilis have been suggested as playing some part in its causation, although nothing definite as to its origin is known. Nodular outgrowths of soft spongy bone gradually develop, increasing slowly in size, and giving rise to

irregular bony protuberances projecting beneath the skin, and when affecting the maxillæ and mandibles leading to an extremely repulsive appearance of the individual. Sometimes merely the cranial bones are affected, at other times only the jaws, whilst occasionally the whole skull participates in the change, which is almost always symmetrical. As growth progresses, the new bone encroaches on the cavities of the skull, so that the antrum may be obliterated, the eyes may protrude owing to the contraction of the intra-orbital space, and even coma and death may supervene from cerebral compression. Prior to this, however, a variety of symptoms, especially neuralgia, may be induced by pressure on the cranial nerves. *Treatment* is only occasionally possible, and consists in the removal of the projecting masses of bone by the chisel.

**Malignant Disease of the Upper Jaw** occurs in the form of sarcoma or cancer. *Sarcoma* is perhaps the more common, and originates either from the anterior wall, from the cavity of the antrum, from the sphenomaxillary fossa behind the bone or may extend into the maxilla from the naso-pharynx. Not unfrequently these growths have a considerable ossific basis, and this is sometimes so extensive as to obliterate the antral cavity, and convert the bone into a solid mass. *Cancer* develops in the form of squamous epithelioma, springing from the gums, or as a columnar or acinous cancer starting in the glandular tissue, found both in the nasal and antral cavities.

The **Clinical Features** of both forms of malignant disease are practically identical.

If arising *from the anterior aspect* of the bone, a tumour is produced which projects under the cheek, the tissues of which are invaded by it, it extends down towards the mouth, and is readily detected through the mucous membrane. It may, however, spread deeply, and in time involve the cavity of the antrum. It causes no obstruction to nasal respiration, and no epiphora except in the later stages.

If it originates *within the antrum*, the usual signs of distension of that cavity are produced, associated with a foul, and often blood-stained, discharge from the nose, within which the ulcerated surface of the growth may be seen. Epiphora is caused by pressure on the nasal duct, whilst the growth has been known to burrow upwards along this passage and project near the inner canthus. The passage of air through the nose on that side is also impeded, and the palate may be depressed.

If the growth commences *behind the maxilla*, it usually springs from one of the walls of the sphenomaxillary fossa, or from the base of the skull, and is then characterized by a great tendency to spread in all directions. It may push the whole bone bodily forwards without encroaching upon the antrum, sometimes it finds its way outwards to the pterygoid fossa through the pterygo-maxillary fissure, or inwards to the nose through the palatine foramen, or even up into the orbit, whilst more rarely it spreads down along the posterior palatine canal, so as to appear at the postero-external

corner of the palate, in the later stages the antral cavity is also involved, and even the base of the skull eroded

The **General Signs** of a malignant growth of the superior maxilla consist in the appearance of a tumour which, in its earlier stages, may produce various effects, but finally tends to destroy the bone and occupy the whole of the maxillary region (Fig 299) It is usually accompanied by nasal obstruction, epiphora, and frequently by a discharge of blood or pus from the nares Severe pain sometimes accompanies the process, especially affecting the second division of the trigeminal Neighbouring lymphatic glands become enlarged, more especially in the carcinomata, those in the submaxillary region are first involved, and afterwards those in the anterior triangle, secondary deposits in the viscera may also occur somewhat later The tumour follows a typical malignant course, and, owing to the great vascularity of the parts, its onward progress is very rapid



FIG 299 —OSTEO SARCOMA OF THE UPPER JAW

The **Diagnosis** of malignant disease of the jaw from a simple tumour should be readily made, the later age at which it usually appears, the rapidity of its growth, the greater pain and more abundant discharge from the nose, the associated enlargement of the lymphatic glands, and the tendency to spread to and encroach upon surrounding structures, all point to malignant disease In some cases, however, an exploratory incision is required to make certain of the diagnosis More frequently the existence of a tumour at all is for some time entirely overlooked, some one prominent symptom, such as neuralgia or epiphora, being treated without ascertaining the cause Transillumination (p 815) may assist in clearing up the diagnosis

**Treatment** consists in free removal of the growth, if such be practicable, together with total or partial ablation of the superior

maxilla Where, however, the tissues of the cheek have been invaded, or where the growth has spread beyond the limits of the antrum, the surgeon may well hesitate before recommending an operation, since complete eradication is always a matter of uncertainty and difficulty, and often secured only at the expense of terrible mutilation and considerable risk to the patient's life Of course, in those cases which spring from behind the maxilla, operative treatment should never be lightly undertaken

**Excision of the Superior Maxilla** varies somewhat in different cases according to the character and extent of the disease

The patient's head and shoulders are well raised, and anæsthesia is maintained by means of chloroform given by Junker's apparatus Preliminary tracheotomy is scarcely necessary or desirable if good assistance is to hand The proceeding may be described in stages as follows

*Stage I Incision and Reflection of the Soft Structures of the Cheek*—The central incisor tooth of the affected side having been extracted, the upper lip is divided in the middle line, the incision is carried round the ala and along the side of the nose, to a point half an inch below the inner canthus, it thence extends along the lower orbital margin to a point below its outer border, or even to the zygoma (Fig 300, A) The flap thus marked out is raised from the bone, and reflected outwards so as to clear the zygomatic eminence, and the more important arteries secured, as they are divided, by Spencer Wells' forceps

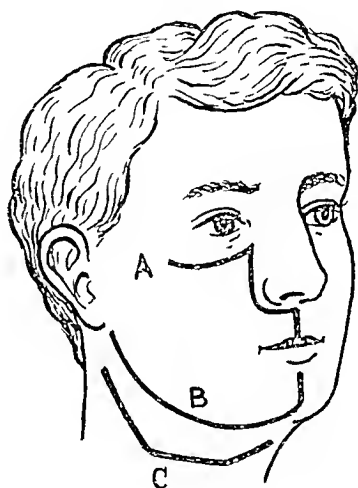


FIG 300 — A, INCISION FOR REMOVAL OF SUPERIOR MAXILLA B, FOR REMOVAL OF LOWER JAW C, FOR REMOVAL OF TONGUE

*Stage II Division of the Bony Attachments*—A keyhole saw is passed into the nose, and the alveolus and hard palate divided from before backwards through the empty socket of the central incisor tooth The side of the nose is then freed from its bony attachments, and the periosteum stripped up from the floor of the orbit The nasal process of the superior maxilla is now cut through with a saw, and also the malar bone divided so as to open into the sphenomaxillary fissure The surgeon then takes a pair of long-handled cutting-pliers, and completes the division of each of these bony attachments, but reversing the order, dealing with the malar bone first, next with the nasal attachments, and finally with the palate The cutting-pliers must always be applied with the smooth surface towards the tissues which are to be left, and the bevelled surface towards the part which is to be removed (Fig 301) When the section of the palate is completed, the cutting-pliers are used as a lever to prise the bone out of its bed, the sound bone acting as a fulcrum, the



posterior attachments being thus fractured. The pterygoid processes are broken through close to their origin from the sphenoid, and the lateral mass of the ethmoid yields along the inner orbital margin.

*Stage III Removal of the Bone and Tumour*—The bone is now seized by lion forceps, one blade holding the alveolus, and the other the infra-orbital border, the mouth is gagged open, and the soft palate, if free from disease, is divided from its attachment to the hard by a transverse incision, and all other connections being severed, the bone is removed. Considerable hæmorrhage may occur at this stage from the infra-orbital and posterior palatine vessels, it is checked temporarily by plugging the wound firmly with a sponge, and subsequently the chief vessels are secured by ligature, whilst smaller

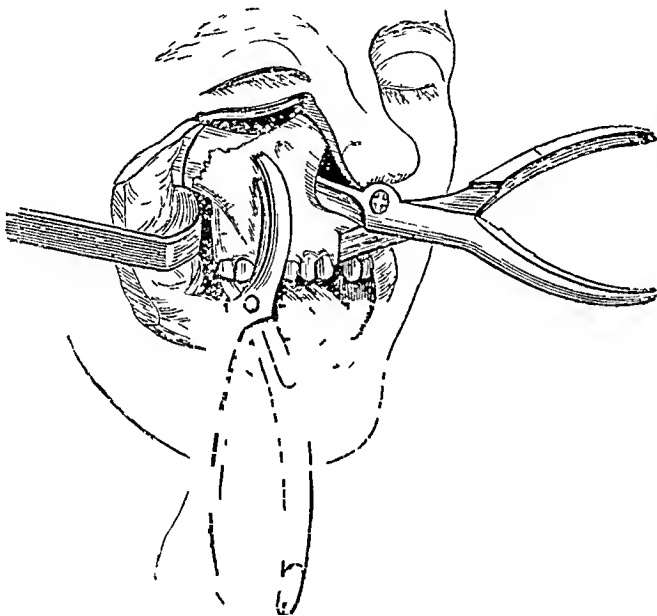


FIG. 301.—EXCISION OF THE SUPERIOR MAXILLA

bleeding-points may be touched with the cautery. Any outlying portions of the tumour are now dealt with, and the cavity, after being dabbed over with a solution of chloride of zinc (40 grains to the ounce), is plugged with strips of sterile gauze. The wound in the cheek is closed, the greatest care being taken to obtain accurate apposition of the flap, especially at the lip margin, and dressed with gauze secured with collodion.

In the majority of cases there is comparatively little shock, and the patients do remarkably well—at any rate, for a time—although, unfortunately, recurrence is only too likely to follow. The plug in the nose is left *in situ* for twenty-four hours and then removed through the mouth, and the wound irrigated with some antiseptic solution. The plug may be replaced, but can usually be dispensed with if the

patient washes out the cavity several times a day. Healing is effected by granulation, and of course a large gap communicating with the mouth remains. This can be subsequently remedied by an obturator to the upper surface of which is attached a plug or cheek plate to prevent falling in of the cheek, and to diminish the cavity of the nose. The patient is fed for the first few days by the rectum, or by a tube passed into the pharynx, but soon acquires the knack of swallowing fluids, especially when the soft palate has been left intact.

Although malignant disease must always be removed with a free hand, yet the amount of deformity caused by a complete extirpation of the maxilla is not inconsiderable, and whenever it is justifiable, the operation should be limited, and no more bone removed than is absolutely essential. In particular, the floor of the orbit should not be needlessly sacrificed, as its removal always involves displacement downwards of the eye, and possibly diplopia. To effect this, the nasal portion of the incision is alone required, the alveolus and hard palate are divided, and then a saw is carried longitudinally outwards from the nares across the bone (*ie*, through the antrum) just below the orbital plate. The posterior connections are dealt with as before. Occasionally a still more limited proceeding may suffice for the removal of an alveolar growth, whilst the upper part of the bone can be taken away without the lower. For these proceedings text-books of operative surgery must be consulted.

Various forms of osteoplastic resection of the superior maxilla required for the treatment of tumours of the naso-pharynx are mentioned later (p 839).

### Tumours of the Lower Jaw

These are similar in character to those met with in the upper jaw. Thus, **Chondroma**, **Osteoma**, **Fibroma**, and the simple and malignant forms of **Epulis**, have been already described.

**Dentigerous Cysts** form around teeth which are so misplaced that they cannot erupt, though occasionally seen in the upper jaw, they



FIG 302 — DENTIGEROUS CYST SHOWING EXPANDED CONDITION OF THE LOWER JAW AND UNERUPTED TOOTH LYING HORIZONTALLY WITHIN IT (COLLEGE OF SURGEONS' MUSEUM)

are much more common in the lower. Their characters and nature have been already described under the title of *follicular odontomes* at p 199. They are met with in young people, and give rise to expansion of the jaw (Fig 302), the tumour thus formed is at first hard and solid to the touch, but later on eggshell-crackling and even true fluctuation are observed when the encasing wall has become thin or absorbed. Irregularity in the line of the permanent teeth may sometimes be noted, but not necessarily, since the milk tooth corresponding to that which is misplaced is not always shed, owing to the absence of pressure from below. Occasionally suppuration within the cavity may be caused by an extension of inflammation from the fang of a neighbouring tooth, or by the cyst being opened during its extraction, and a sinus discharging offensive pus will then form. *Treatment* consists in freely opening the cyst through the mucous membrane, and removing a sufficient portion of the bony wall to allow of the removal of the misplaced tooth. The cavity is

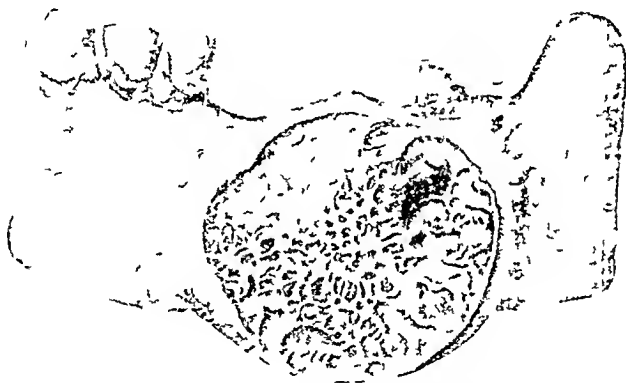


FIG 303 —FIBRO CYSTIC DISEASE OF THE LOWER JAW

(By kind permission of the Council of the Royal College of Surgeons)

left open and allowed to heal by granulation, during which process strict attention to cleanliness must be observed.

**Fibro-cystic Disease of the Jaw** (*epithelial odontome*, p 199) has been already mentioned as characterized by the formation of a tumour, often of great size, which consists of spaces lined with cuboidal epithelium, and supposed to originate from the enamel organ (Fig 303). It occurs most frequently in young people, and, as a rule, runs a perfectly benign course, although when of large size it may lead to serious results. The only *Treatment* consists in complete removal of the affected portion of the jaw.

**Myeloid Sarcoma** is met with in the lower jaw, not only in the form of a malignant epulis, but also occasionally as a central growth, usually attacking the median portion of the bone, which becomes expanded in the same way as when a similar disease invades the end of a long bone. It presents but slight evidences of malignancy, and may be treated in the first place by opening the outer shell of bone

and scraping away the soft contents, the cavity thus formed being swabbed out with pure carbolic acid, and plugged with gauze. Should it recur, the affected portion of the bone must be removed, although, whenever possible, a bridge of osseous tissue is left so as to connect the two segments of the jaw, if this is not attended to, they are likely to fall together, and lead to considerable trouble. If the whole thickness of the bone is excised, a wire frame or splint should at once be introduced between the fragments with the same object. It is replaced later on by a suitable plate carrying artificial teeth.

**Round- or Spindle-Celled Sarcoma** also occurs, usually springing from the periosteum, the deeper parts undergoing ossification (Fig 304)



FIG 304 —OSTEO SARCOMA OF THE LOWER JAW

The course is typically malignant, and free removal of the affected portion of the bone must be undertaken.

**Epithelioma** invades the lower jaw as an extension of a similar affection arising either from the gum, lips, or tongue. Excision of a portion of the bone together with the primary disease is always required, unless it has extended so far as to render extirpation impracticable.

Excision of the Lower Jaw is employed in the treatment of various tumours arising from that bone, as also sometimes for extensive necrosis. In the latter case it may be possible to deal with it from the mouth, but when required for the treatment of malignant disease an external incision is absolutely essential.

If the whole of one side is to be removed, an incision is made, reaching from just below the red margin of the lip downwards to a

point immediately below the symphysis, and thence along the under surface of the body of the jaw as far as the angle, it is then prolonged upwards along the posterior border of the vertical ramus, not extending further than the attachment of the lobule of the ear, so as to avoid the facial nerve (Fig 300, B). When a large tumour is being dealt with, the whole thickness of the lip should be divided, and the flap thus marked out dissected off the bone, and turned outwards. Where, however, the upper portion of the lip is left, the incisions are carried down to the bone, the facial vessels being secured above and below before division. The soft parts are then freed from the outer aspect of the bone, and the cavity of the mouth opened. The central incisor tooth is drawn, and the jaw divided through the empty socket with a saw and cutting-pliers. By this means the genial tubercles and their attached muscles are not encroached on, or the movements of the tongue impaired. The bone is seized and drawn outwards, and its internal connections as far as the angle divided. It is then firmly depressed, and the muscular attachments of the masseter on the outer side, and of the internal pterygoid on the inner, cut through, as also the inferior dental nerve and artery. By still further depressing the bone, the temporal tendon is exposed, and should be divided by successive touches of the knife, which is kept close to the bone. Finally, the condyle is freed after division of the external pterygoid muscle and of the ligaments of the temporo-maxillary articulation. The proximity of the internal maxillary artery to the inner aspect of the neck of the bone must be remembered. After hæmorrhage has been arrested, the wound is stitched together and dressed with collodion and gauze, possibly a drainage-tube may be inserted with advantage for a few days through the floor of the mouth. Considerable deformity usually results from this operation, owing to the remaining half of the bone being drawn across the middle line.

### Diseases of the Temporo-Maxillary Articulation

**Acute Synovitis** may supervene in the course of an attack of rheumatic fever, and is evidenced by pain on movement of the jaw, and by tenderness and swelling immediately beneath the root of the zygoma, due to effusion into and around the joint. Resolution usually follows, but fibroid thickening of the ligaments and impairment of movement may result.

**Acute Arthritis** arises from pyæmic infection after the exanthemata, or from gonorrhœa, but may be caused by direct extension of inflammation from the middle ear, as in scarlatina. It occurs in children, and is due 'to the persistence of a hiatus in that part of the tympanic plate which forms the floor of the meatus and the roof of the articulation' (Barker). It is characterized by the usual signs of a severe localized inflammation, with the formation of abscesses, and results commonly in ankylosis. Localized fomentations and the antiseptic opening of abscesses constitute the only early treatment, whilst excision of the condyle is sometimes required at a later date.

**Osteo-arthritis** is by no means a rare affection of this joint. It is often symmetrical, and characterized by an enlargement of the condyle, which can be felt distinctly in front of the tragus, especially on opening the mouth, when crepitus is also noticed. The pain is worse at night and in wet weather, and the jaw becomes deflected to the sound side if the disease is unilateral, when both sides are affected, the jaw is pushed forwards, and the chin projects. The articular cartilage undergoes the usual changes, the inter-articular cartilage disappears, and the glenoid cavity becomes enlarged and flattened, so that the eminentia articularis is relatively less marked, thus permitting the external pterygoid muscle to draw the condyle forwards. After a time, considerable difficulty is experienced in opening the mouth, even amounting to ankylosis. Ordinary medical *treatment* may be used in the early stages, but in the later the condyle of the jaw should be excised, a proceeding followed by excellent results.

**Tuberculous Disease** may arise either in the bone or synovial membrane, perhaps spreading to it from neighbouring lymphatic glands. It runs the usual course of the disease, terminating in caries of the condyle, and ankylosis after protracted suppuration, to prevent this, excision of the condyle is indicated.

**Immobility or Closure of the Jaw** may be caused by a variety of conditions

1 True ankylosis of the temporo-maxillary joint, fibrous or osseous, as the result of any of the diseases mentioned above.

2 Cicatricial contraction of the soft structures either within or without the mouth, as from burns, lupus, or extensive operations in the pterygoid region upon the roots of the fifth nerve, from cancrum oris, or very rarely from myositis ossificans.

3 Spasm of the muscles of the jaw (*trismus*), due to reflex irritation, as from carious teeth, or an unerupted wisdom-tooth, or some other local lesion. It is occasionally hysterical, and is one of the early symptoms of tetanus.

4 Local inflammatory conditions often render opening of the mouth impossible, both from the pain and swelling—e.g., in mumps, parotid abscess, acute alveolar periostitis—whilst in epithelioma and various forms of tumour the size of the growth may seriously impair the mobility of the jaw.

The term ankylosis can only be applied to the conditions mentioned in the first two groups. In the others appropriate treatment must be instituted according to the character of the affection. Where the closure of the jaw is permanent, it may be due to osseous ankylosis, the bony masses extending not only between the articular surfaces, but also between the alveoli, or to fibrous adhesions within the joint, or to extra-articular contraction of the soft parts, not only the skin and mucous membrane being involved, but also frequently the muscles and deeper structures.

Division of the neck of the bone or excision of the head may thus be impracticable, or, even if possible, is useless, since the muscles of the jaw hold the surfaces in such good apposition as to bring about

a recurrence of bony union, unless obviated by implanting a flap of the temporal muscle or a vulcanite plate between the bony surfaces. Division of the intra or extra-buccal cicatrices is unsatisfactory, owing to their rapid re-formation. The best *treatment* in most cases is either removal of the vertical ramus of the jaw down to the level of the alveolus, or the plan suggested by Esmarch, viz, excision of a wedge of bone, with its apex towards the alveolar border, from the neighbourhood of the angle, and the establishment of an artificial joint at that spot. The incision should be made below and behind the angle down to the bone, from which the periosteum is stripped up, and division is accomplished by means of the saw.

**Excision of the Condyle of the Jaw** is not always a simple operation, since the space at the surgeon's disposal is limited by the zygoma above, the facial nerve below, the parotid gland in front, and the external ear behind. The best incision is a curvilinear one, commencing over the middle of the zygoma, and passing downwards in front of the tragus. It should merely divide the skin and subcutaneous tissue, and the flap thus marked out is turned forwards. A transverse incision is now made through the deep fascia immediately below the posterior extremity of the zygoma, extending down to the neck of the bone, which is cleared by a raspatory and divided by cutting-pliers, the condyle is then grasped by necrosis forceps, and twisted out. But little bleeding occurs, and the wound heals by first intention except along the track of the drainage tube, which should always be employed.

## CHAPTER XXVIII

### AFFECTIONS OF THE NOSE AND NASO-PHARYNX

**Affections of the Outer Nose**—Several forms of **Injury**, including fracture of the nasal bones and separation of the cartilages, have been already noticed (p 478)

**Depression or Flattening of the Bridge of the Nose** is either a result of traumatism, such as a fracture of the nasal bones, or may arise from defective growth of the ethmo-vomerine septum, due to disease either of syphilitic or tuberculous origin early in life, whilst it may also result from similar conditions occurring in the course of tertiary syphilis. If caused by injury, and dealt with promptly, it may be remedied, but when once acquired, and especially if the consequence of disease, treatment is much less satisfactory. Several cases have been recorded, however, in which bone-grafting has been successful. An incision is made down the middle line of the nose, the soft parts are reflected on either side, and, after making a comfortable bed for it, the bone graft is introduced, and kept in position partly by sutures, but mainly by closing up the wound in the soft tissues. In one case the patient's own fourth metatarsal bone was utilized with success, whilst platinum, gold, or celluloid frames have also been employed in the same way.

The subcutaneous *injection of paraffin* has been utilized in many of the worst cases with advantage. A paraffin is employed which melts at 110° F, this is slowly injected into the subcutaneous tissue through a specially adapted syringe. Whilst still fluid, it can be moulded into the required shape, but careful pressure has to be exercised to prevent it from spreading into the eyelid or cheek, where it would form an unsightly bulge. The paraffin is supposed to remain permanently as an infiltration of the tissues, but further experience is required to make sure that this is the case.

**Expansion of the Bridge of the Nose** is always the outcome of some long continued intranasal pressure, especially from the growth of polypi. It rarely follows the development of mucous polypi, except when they are very large and chronic, but it is not an uncommon accompaniment of the fibrous or fibro-sarcomatous variety. The bridge is flattened and bulged out on either side, giving the face an appearance justifying the name 'frog-nose' which has been applied to it.



Congenital swellings at the root of the nose are not altogether uncommon, and consist either of a meningocele (p 742), or of a dermoid cyst which may have a deep connection between the nasal bones with the cerebral membranes. It is not always advisable to deal with them in the early years of life, since their intracranial connections may be shut off as the child grows up.

It is impossible to discuss all the different affections of the skin of the nose. Many of them are associated with the sebaceous glands, which in this region are very large and abundant. Thus, *acne* is commonly met with, arising from an inflammation of the glands after obstruction to their ducts. It is especially frequent in drinkers and dyspeptics, women addicted to tea-drinking often suffering severely. When the superficial capillaries become markedly dilated and the face readily flushes on the imbibition of hot or stimulating fluids, the term *rosacea* is attached to it, whilst if *acne* pustules are also present, it is known as *acne rosacea*. Sometimes the spots become much enlarged, and there is a considerable amount of infiltration of the base, a condition described as *acne hypertrophicum*. In the most exaggerated stage the sebaceous glands become overgrown and form large protuberant nodular masses projecting from



FIG 305 — RHINOPHYMA OR HAMMER NOSE (TILLMANN'S)

the end of the nose, and covered with red greasy skin, in which the dilated orifices of the glands are very evident, and with dilated capillaries coursing freely over them. This condition is generally known as *lipoma nasi*, *rhinophyma*, or *hammer-nose* (Fig 305). The Treatment of simple *acne* consists in correcting the dyspepsia, and limiting the amount of, or interdicting entirely, alcohol or tea. Capsules of ichthyol (3 to 10 minims) may also be administered thrice daily, and soothing applications should be used locally, such as a lotion consisting of calamine, oxide of zinc, and precipitated sulphur, held in suspension with glycerine and lime water. Dilated and unsightly capillaries may be dealt with by puncturing them with the galvano-cautery or an electrolytic needle. Rhinophyma requires operative proceedings, the protuberant mass should be freely dissected away from the cartilages, and the raw surface either left to cicatrize, or dealt with by Thiersch's method of skin-grafting.

Partial or Total Destruction of the Nose may result from traumatism, but usually from some chronic inflammatory or malignant growth, such as lupus, tertiary syphilis, or rodent ulcer. Epithelioma sometimes attacks it, and requires total removal of the nose for its cure. In any of these conditions the resulting deformity is so repulsive that the surgeon is certain to be asked to undertake some proceeding to remedy it. Indian surgeons have had a good deal of experience

in this direction, since in that country cutting off the nose is often resorted to as a means of avenging some real or fancied wrong. Various plastic operations have been devised, which, however, we can only indicate briefly here, referring students to larger works of operative surgery for fuller details.

The chief methods of **Rhinoplasty** are as follows

1 The so called *Indian method*\* consists in the formation of a nose from a flap of skin obtained from the forehead. The flap (Fig 306) is more or less pyriform, with the pedicle so placed as to contain one of the frontal arteries and the supra trochlear nerve. Necessarily its exact shape and size vary with the character of the defect and with the type of nose desired. Keegan, who has done some excellent work in this direction, advises that the skin covering the nasal bones, as high as the level where the bridge of spectacles would rest, should first be turned down in two flaps, using their attachment to the nasal mucosa as a hinge, so that the cutaneous surface shall look inwards and the raw surface outwards. Over these the forehead flap is placed, and there should be sufficient tissue in the nasal flaps to enable their free ends to be stitched below to the forehead flap on either side of the columna thus completing the anterior nares. The columna itself is formed by the free end of the forehead flap. Drainage tubes are inserted through the anterior nares and kept in position for ten to fourteen days. The lateral margins of the flap are carefully sutured to the freshened edges of the defect. When the union of the lower portion is sufficiently firm, the nose is made more shapely by partially dividing the twisted pedicle but if possible the integrity of the frontal artery should still be retained. The wound in the forehead is drawn together as far as possible by sutures and healing promoted later by skin grafting.

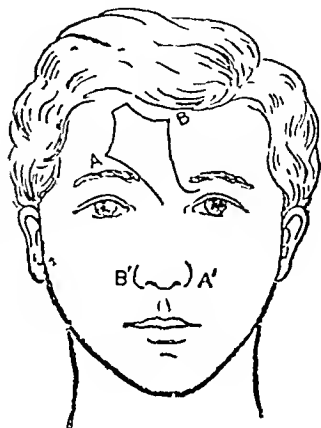


FIG 306 — INDIAN METHOD OF RHINOPLASTY, SHOWING THE SHAPE AND POSITION OF THE FOREHEAD FLAP

The points A and B are brought down to A' and B' when the flap is twisted into position

2 In the *Tagliacozzian* or *Italian operation* (so called from Tagliacozzi, the surgeon who first proposed it) a flap of skin is taken from the arm. The pedicle must always be broad, and is left attached to the upper part of the inner aspect of the arm. It must be so placed that it can be brought into apposition with the nasal defect without tension. The fore-arm and hand being fixed by a suitable apparatus above the head and retained there until good union has been accomplished, when the pedicle is gradually divided. Absolute fixation of the arm is an essential, and as this may need to be maintained for two or three weeks, the patient needs a considerable amount of pluck and perseverance. When the pedicle has been detached subsequent plastic measures are required to mould the new tissue to the shape of the nose.

3 The cheeks have also been made use of in what is known as the *French method* to supply material for the nose flaps being dissected up from either side, and united in the middle line.

4 The above operations have the great objection that the new nose only consists of soft tissues, and hence is very likely to shrivel up and contract, so that all that is finally obtained is a covering for the defect, which is often quite flush with the surface. To obviate this and to secure a bony basis for the nose, attempts have been made to utilize a finger for the purpose, and Mr Astley

\* For full details of this plan we would refer to Keegan's 'Rhinoplastic Operations' Baillière, Tindall and Cox, 1900

Bloam has had one or more successful cases. The terminal phalanx is removed, the soft parts split down the middle line on the palmar aspect, and the divided segments united by suture to the margins of the nasal defect. When union is secured, the amputation of the finger is completed.

Naturally, where only a portion of the nose is destroyed, partial operations can be devised to meet the requirements of the case.

**Examination of the Nasal Fossæ and Naso-Pharynx**—In order to understand fully the diseases of the nose, it is essential that the interior of the organ be efficiently examined, and to do this three chief methods are employed.

1 *Anterior rhinoscopy* consists in the illumination of the front of the nasal cavity through the anterior nares. A good light is required, such as that derived from an electric head-lamp, and some form of nasal speculum. Perhaps Thudichum's speculum is one of the best, it consists of two unfenestrated blades, connected by a U-shaped spring, which is held in the hand, whilst the blades are inserted into the nostril, the nasal vibrissæ being thus held aside, the ring and index fingers are placed one on each limb, so as to regulate the amount of tension, and prevent painful overstretching. By this or similar means one is enabled to see the anterior part of the nasal fossæ, including the inferior turbinal and the erectile tissue at its anterior extremity. The amount of distension of the latter limits the view of other structures, if greatly swollen, it feels soft and even fluctuating, but collapses entirely on the application of a 5 per cent solution of cocaine, allowing the free convex border of the middle turbinal to come into view, as also the cleft or olfactory fissure between it and the septum. The septum can also be examined, frequently showing deviations from the middle line, and thickenings or spurs of bone or cartilage, which run in an antero-posterior or vertical direction. A certain amount of erectile tissue is also present on the septum.

The introduction of a sterilized probe under the guidance of the eye is of the greatest value in examining the nose. It not only serves to distinguish the different qualities of growth that can be seen, but will also give information concerning regions beyond the surgeon's eye.

2 By *posterior rhinoscopy* is meant an examination of the posterior nares by a mirror placed behind the uvula and soft palate. It is by no means easy to accomplish, and requires some dexterity and practice. The tongue should be depressed, and a small mirror, previously warmed to prevent condensation of moisture, is then passed behind the uvula, without touching it or the posterior wall of the pharynx, and by shifting its angle and position a view should be obtained of the structures exposed posteriorly. If not successful, and it is absolutely necessary to obtain a view, the fauces should be cocaineized and the velum held up by some form of palate retractor, such as White's. The posterior nares (or choanæ) are seen, separated by the vertical posterior free margin of the septum, and within each cavity the rounded ends of the turbinals with the meatuses inter

vening The inferior meatus often looks very small owing to the prominence of the velum palati, whilst the middle meatus may be encroached on by tumefaction of the erectile tissue at the back of the inferior spongy bone Outside the choanæ are seen the yellowish openings of the Eustachian tubes, whilst above and between them Luschka's tonsil, a raised collection of lymphoid tissue in the roof of the pharynx, is occasionally observed

3 *Palpation of the Posterior Nares* with the index finger, previously disinfected, will, however, give better results in the majority of cases to those who are not specially practised in the above method The index finger is passed behind the uvula and velum, and the nares can then be well explored, and the existence of adenoids or other growths determined

**Foreign Bodies** are rarely impacted in the nasal passages except in children, in whom the condition is not uncommon Any unilateral purulent discharge from a child's nose should suggest the likelihood of such an occurrence, peas, beads, or buttons, being the substances usually introduced A certain amount of unilateral obstruction to nasal respiration is caused thereby, followed by a catarrhal or even suppurative rhinitis, and in old standing cases a rhinolith or nasal calculus may be caused by the deposit of inspissated mucus upon the outer surface of a foreign body Removal is often effected by syringing out through the unaffected nostril, the lotion rushing back through the other side, and carrying the intruding body before it Failing this, the child should be anæsthetized and a forceps or scoop employed, the surgeon's manipulations being guided by a rhinoscope and frontal illumination Necessarily, all instruments used for this purpose should be thoroughly sterilized After the removal, the nostrils are carefully washed out for a few days with a weak alkaline antiseptic lotion, such as salt and water to which a little sanitas has been added

**Acute Rhinitis**—Several distinct varieties of this affection are described

1 The **Catarrhal** form is extremely common, constituting what is popularly known as a 'cold in the head' Not only is the nasal mucosa involved, but the inflammation often extends to the frontal or maxillary sinuses, causing brow-ache and face-ache, whilst if it spreads to the mucous lining of the Eustachian tube, temporary deafness may ensue In infants great dyspnœa often results owing to the extreme narrowness of the nasal passages, and this may be so marked as to interfere for a time with breast feeding Apart from the usual domestic remedies directed to increasing the action of the bowels, kidneys, and skin, considerable relief can often be obtained by washing out the nasal cavities three or four times a day with a weak warm alkaline lotion containing borax and possibly a little menthol

2 A **Suppurative** form arises not unfrequently as a result of acute suppuration in one of the accessory sinuses (acute empyema), and then treatment must be mainly directed to the sinus Occasionally

it is due to gonorrhœal infection either in adults or infants, but perhaps more commonly in the latter. The discharge is abundant, and causes much obstruction to nasal respiration, whilst ulceration is likely to occur. The passages must be well cleansed with a solution of boric acid several times daily, and the interior sprayed or painted with a weak solution of nitrate of silver (gr 5 to 1 ounce) once every day as long as the suppuration continues.

3 True diphtheria also occurs in the nasal fossæ, usually as a complication of the same disease elsewhere, and requiring a similar form of treatment.

**Chronic Rhinitis** occurs in many distinct types, of which we can merely give a bare outline\*. One of the most common forms is characterized by engorgement of the erectile tissue covering the inferior turbinated bone, causing obstruction to nasal respiration and an abundant discharge of muco-pus. It usually occurs in patients with prominent noses, where the passages are narrow, and in consequence the air pressure is diminished, it may be lighted up by some slight local irritant, such as a sudden change of temperature. The anterior end of the inferior turbinal is swollen, red, and rounded, the mucous covering being œdematous, and the mass feeling, on touching it with a probe, like a sac full of fluid. The local application of a 5 per cent solution of cocaine causes its complete, though temporary, collapse in a few moments. If it is allowed to persist, hypertrophy of the mucous membrane follows, and in the most marked types a projecting papillomatous-like mass, almost resembling a polypus, results. It is, however, merely an inflammatory hyperplasia, and not a new growth, true papillomata are extremely rare in this situation. The posterior end of the bone may be similarly affected, and the mucous covering of the middle turbinal may participate in the same process. A certain amount of pharyngitis or laryngo-tracheitis may also be present. *Treatment* — In the early stages all that is required is to wash out the nasal cavity night and morning with some simple nose lotion, such as borax or bicarbonate of soda (5 grains to 1 ounce). This may be accomplished either by sniffing the solution from the palm of the hand, or by using some form of nasal douche, Basdon's douche is perhaps the best for this purpose. If such is insufficient to give relief, or if collapse is not produced by cocaine, the surface may be swabbed over with some diluted caustic, or, better still, a point of galvano cautery at a red heat may be run along the length of the bone. In the later stages removal of the hypertrophied excrescences by the cold-wire snare, or by the galvano écraseur, is required.

Another group of cases of chronic rhinitis is associated with collapse of the erectile tissue, and then there is but little discharge, since the exudation dries within the nasal cavities and forms inspissated crusts or scabs which are often difficult to remove (*rhinitis sicca*). The nasal fossæ are in this case more patulous than usual, and a dry

\* For further details, consult Greville Macdonald's *Diseases of the Nose*. Alex. P. Watt and Son. Second edition, 1892.

pharyngitis and chronic laryngitis are often present Both nostrils may be involved, but occasionally the affection results from deviations of, or cartilaginous excrescences (spurs) from, the septum, and then is unilateral, the discharge coming from that side which is most patulous, whilst the narrowed side remains healthy When symmetrical, the disease is rather due to constitutional than to local causes, occurring in weakly, anæmic women, and is to be treated by general rather than local measures In the unilateral form, deviations of the septum from the middle line must be rectified, or the spur removed by the saw In this way the inspired air is made to pass more freely along the narrowed healthy side, and the other nostril is dealt with by the use of weak alkaline lotions It may also be advisable to plug the dilated side with cotton-wool for some time daily, so as to enforce respiration through the other nostril Treatment is always likely to be prolonged, and it is possible that a daily alkaline nose lotion may be needed permanently Stimulating applications are never borne well, and hence should rarely be ordered

**Ozæna** — This term was formerly applied to any offensive mucopurulent discharge from the nostrils, whatever the cause, and thus was made to include such conditions as tuberculous or syphilitic disease of the turbinated bones or of the septum, suppuration in the accessory sinuses, the impaction of foreign bodies, or the ulceration of malignant growths Improvements in differential diagnosis have reduced the cases of ozæna to a very small number, and the term is now limited to one particular affection, and that a special *atrophic* form of *rinitis sicca*

The disease is usually met with in young females, and may sometimes originate from traumatism, or after one of the exanthemata, or is associated with inherited tuberculosis or syphilis The nose is almost always wide and roomy, and may be of the special strumous type, the lips are often thick and everted, and the mouth is usually held open owing to the impediment to nasal respiration caused by inspissated mucus The fœtor of the breath due to the decomposition of this discharge is the special feature that calls attention to the complaint, it is peculiarly searching and objectionable, but the patient fortunately is not cognizant of it There is not much discharge, but at varying periods large crusts come away, giving relief both to the nasal respiration and to the fœtor Both nostrils are usually involved

On examination, the nares are found to be unusually patulous, and the vibrissæ are scanty The mucous membrane over the turbinated bones is dry, collapsed, and pale, so that after clearing away all the dried mucus and scabs, it is often possible to see the posterior pharyngeal wall, and even the orifices of the Eustachian tubes The pharyngeal wall is also dry, and may be coated with a film of inspissated mucus No ulceration is present, although the removal of the crusts may be associated with a slight amount of bleeding owing to their close attachment to the mucous membrane

The examination of a case of suspected *ozæna* should also include the accessory cavities of the nose, since many cases in which crust-formation is a prominent symptom are really due to an empyema of one or more of the sinuses

The chief *ætiological* factor is the wide, roomy nose, from which it is difficult to expel the exudation arising from any ordinary rhinitis, and hence the discharge tends to collect and necessarily to putrefy. For the same cause the mucous membrane becomes dry and the erectile tissue collapses, so that an atrophic form of rhinitis *sicca* results, followed in time by sclerosis and shrinking of the turbinated bones. It is always a prolonged process, although in the course of years it improves and gradually disappears.

**Treatment**—The first essential is to keep the nose clean and free from putrefying masses of dried secretion. This must be accomplished by irrigating the cavity once or twice daily with a warm weak solution of common salt to which a little *sanitas* has been added. At first it is well for the surgeon to see to this himself, but after a while the patient or her friends can be entrusted with the task. Every portion of scab ought to be removed daily, and the surface lubricated with some such application as a spray of menthol and paroleine (10 grains to 1 ounce). The nose should then be partially plugged with a tampon of cotton-wool, especially along the lower meatus, and if thought desirable the wool may be medicated with some antiseptic. By this means a flow of mucus from the membrane is determined, and the discharge is thus rendered more fluid, and inspissation prevented. A similar end may also be obtained by partially plugging the nostril with an indiarubber tube, so as to diminish its size. The general health must be attended to, and patience and perseverance will generally be crowned with success. Operative measures are scarcely ever required in this disease, although they have frequently been resorted to most unnecessarily.

**Disease of the Middle Turbinated Bone and Ethmoid** is sometimes the cause of an offensive purulent discharge from the nose, which is often wrongly called *ozæna*. It occurs in individuals of all ages and classes, arising from syphilitic or tuberculous disease, but is perhaps most commonly due to septic infection from without, the result of meddling and careless surgery. It must be remembered that the upper part of the nose is normally sterile, and the introduction of dirty instruments is often responsible for this affection. It commences as a submucous infiltration, usually of the middle turbinal, and thence spreads, with or without ulceration, to the periosteum covering the bone, which becomes carious or necrosed. Various parts of the ethmoid, including the cribriform plate, may also be involved, and adjacent bony cavities (antrum, frontal and ethmoidal sinuses, etc.) are filled with pus. In bad cases the venous channels in the base of the skull—*e.g.*, the cavernous sinus—may be thrombosed and infected, and even abscess of the brain has followed. The disease affects one or both sides of the nose, perhaps most

frequently but one. On examining the interior of the nostril, there is no patency of the cavity, as in ozæna, but a large polypoid mass of granulation tissue may be seen blocking the middle meatus and covered with a half-dried scab, whilst pus can be seen to exude from it when pressed upon, this usually comes from the antrum or frontal sinus, the mass of granulation tissue lying both above and below the entrance. A probe passed into the mass always impinges on diseased or bare bone.

When due to syphilis, distinct sequestra are usually present, sometimes involving the septum and hard palate, but the accessory cavities are not generally invaded.

The **Diagnosis** from ozæna is made by remembering that in the latter the characteristic features are the abnormal width of the nasal fossæ, the bilateral symmetry, the collapse of the erectile tissue, the more complete inspissation of the secretion, and the pathognomonic stench, which are all absent in these cases. A certain amount of odour is present, but it is mainly noticed by the patient, not so much by outsiders.

**Treatment** consists in the removal of all dead and carious bone that can be safely dealt with, together with the destruction of all fungating granulation tissue, and the drainage of such accessory cavities as can be reached, whilst attention is given to maintain cleanliness and asepsis as far as possible. Thus, the middle turbinated bone and its accompanying mass of granulation tissue may be removed by the sharp spoon, snare, or polypus forceps. The antrum must, if necessary, be opened and drained, and the walls of the ethmoidal cells may be broken down, and exit thus given to pus. The greatest gentleness and care must be exercised when any attempt is made to deal with the roof of the nose.

**Nasal Polypi**—Two forms of nasal polypus are described, viz, the simple or mucous polyp, and the fibrous or fibro-sarcomatous. Other malignant tumours occur in the nasal fossæ, to which, however, the term polypus can scarcely be extended, they mainly originate from the superior maxilla.

The **Mucous Polypus** consists of a soft gelatinous mass, which on microscopic examination much resembles myxomatous tissue, covered by ciliated columnar epithelium, and supplied freely with bloodvessels. The general opinion of rhinologists is in favour of the view that polypi are ~~inflammatory in origin~~, consisting merely of œdematous hypertrophic tissue, sometimes dependent on, and kept up by, suppuration in one of the adjacent sinuses, sometimes due to disease of the underlying turbinal, but not unfrequently occurring apart from any obvious lesion. They are usually situated on the middle and superior turbinals, they rarely start from the roof of the nasal fossæ, occasionally in the sinuses, or at the orifices leading into them, they hardly ever involve the septum or inferior turbinated bone. The polypoid masses are generally multiple, a large one projecting downwards and forwards towards the anterior nares, and covering or hiding a whole series of smaller ones, which readily



spring into prominence when that in front is removed. They are usually attached by a small pedicle, and when developing in the nasal ossa are pyriform and laterally compressed. When of large size, they may protrude through the nostrils, and then the epithelium covering the anterior portion becomes squamous, and the whole mass firmer in texture and papillomatous in appearance. Sometimes they project backwards into the pharynx, and are then more distinctly globular and usually single. Occasionally they are the starting-point of a myxo-sarcomatous growth, which develops rapidly, and early tends to invade the surrounding bones.

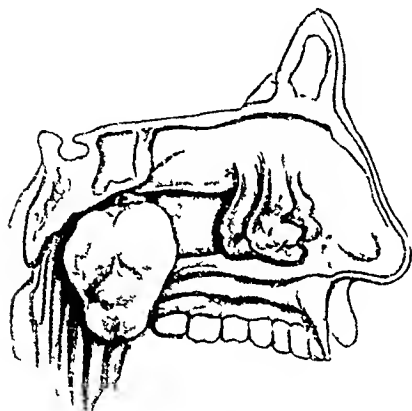


FIG. 307.—MUCOUS POLYPI OF NOSE, SPRINGING FROM THE BACK AND FRONT OF THE MIDDLE TURBINATED BONE

The main **Symptom** arising from nasal polypi is obstruction to the passage of air along one or both sides of the nose, according to the location of the growths. This is always of gradual onset, and is invariably worse in wet weather, on account of the hygroscopic property of mucoid tissue. There is often a thin, watery discharge from the nose, which may perhaps be blood-stained. The patient is unable to blow the nose, and his articulation becomes nasal in quality. On rhinoscopic examination one finds a grayish semi-translucent glistening mass occupying the nostril, and attempts to blow the nose render this more obvious. Its pedunculated nature can be easily demonstrated by passing a probe around it.

When of large size, some flattening or expansion of the bridge of the nose may be caused thereby, and possibly epiphora from pressure on the opening of the nasal duct.

The **Diagnosis** should present no difficulty to one who knows how to employ the nasal speculum. Abscess, a spur, or deviation of the septum, though causing unilateral obstruction, is recognised by the exercise of a very small amount of intelligence. Oedematous masses of granulation tissue, associated with tuberculous or syphilitic disease of the bones, are recognised by usually involving the septum as well as the turbinates, by the purulent discharge, by the absence of superficial epithelium, and by not being distinctly pedunculated. Carious bone can usually be felt by a probe through the granulation tissue. From hypertrophy of the mucous membrane over the inferior turbinated bone, a polypus is known by the fact that it scarcely ever springs from this region, whilst the former condition is sessile and red, and diminishes considerably in size by the application of cocaine.

The **Treatment** of mucous polypi consists in their removal either by forceps or the snare. The former plan is usually condemned by rhinologists as unscientific and barbarous, and as utilized by many

of the old class of surgeons, such it certainly was, but if employed in the way described below, it is just as efficient as the snare, and gives the patient very little, if any, more pain. Personally, we must plead guilty to a very distinct preference for the forceps.

In undertaking avulsion by forceps, the patient is seated in a chair, and the surgeon sits or stands in front of him. The nasal cavities are well sprayed with a solution of cocaine and adrenalin, and the situation of the pedicle ascertained by inspection and by the use of a probe. The forceps employed should be long, with delicate, though strong, blades, which are deeply serrated on either side of a median groove. They are introduced open, with a blade placed horizontally on either side of the growth, and are gently pressed upwards until the pedicle is grasped as close to the turbinated bone as possible. The blades are then closed firmly, and the polyp twisted off and removed, a certain amount of hæmorrhage resulting. The same process is repeated to the smaller tumours until the nostril is clear. It may be plugged with a strip of boric lint if there is much bleeding, but such should never be left unchanged longer than twenty-four hours. The plug is then removed, and the base of the growth carefully examined and cauterized with the galvano cautery by the aid of a nasal speculum. This cannot be so accurately accomplished immediately after removal, as the bleeding interferes with clear vision. The cauterization of the base is a most important item in the treatment, as without it the growths are sure to recur. The patient should be again examined after a short interval, so that any smaller polypi which have commenced to develop may be suitably dealt with.

To remove polypi with the galvanic *écraseur* or snare, a speculum is inserted, and the wire loop passed round the growth so as to encircle its base, and gradually tightened until it has cut through. This plan is specially adapted to large masses which project downwards behind the palate.

Whichever method is adopted, recurrences are not uncommon, and the treatment may in consequence be very prolonged, but if the surgeon will persevere in the way described above, the disease can in time be eradicated without having recourse to such a mutilating procedure as removal of the turbinated bones, indeed, after such an operation, considerable trouble may arise from the nasal cavity being too patulous.

**A Fibrous Polypus** is the term applied to a fibroma, which tends sooner or later to become sarcomatous, springing from the base of the skull, especially from the basi-sphenoid or basi-occipital. It is at first distinctly pedunculated, and is usually firm, smooth, and fleshy in character, when of large size, it may be lobulated. The early symptoms are almost limited to those of obstruction to nasal respiration, but to this is not unfrequently added severe epistaxis, owing to the vascularity of the capsule and of the overlying mucous membrane. As it increases in size, ulceration occurs, leading to a foetid sanious discharge, and the growth rarely remains limited to the nasal fossæ. If pushing forwards, it may lead to expansion of the bridge of the

nose and separation of the eyes, which may even be made to diverge, but if backwards, it may depress the velum, and hang downwards as a naso-pharyngeal tumour. In other cases it may force its way into the orbit or any of the other surrounding cavities, or may even erode the base of the skull, and encroach upon the cranium. It is rare for any of these latter manifestations to occur until after the tumour has taken on a distinct sarcomatous type.

The disease usually attacks young people, and mainly those in the second decade of life. It progresses with considerable rapidity, and the fatal issue may be due to hæmorrhage, asphyxia, or cerebral complications.

**Treatment**—Unfortunately, this condition is but rarely recognised in the early stages, owing to the fact that the majority of practitioners are quite unable to use the rhinoscope. We would impress upon students the immense importance of thoroughly exploring both by the mirror and the finger passed behind the velum every case of nasal obstruction or of chronic discharge from the nose. When the growth is small and polypoid, it can often be dealt with from the anterior nares by means of a galvano-écraseur. The wire loop is inserted from the front, and hitched over the tumour, so as to encircle its base, by the assistance of the right index finger passed behind the velum. The pedicle must be divided as near the skull as possible, as otherwise recurrence is almost certain to follow. Nélaton's operation, described below (p. 839), will in some instances assist the surgeon to reach the base of the skull and deal with the tumour.

In the more severe cases, where the growth has become diffuse, it is very doubtful whether much good can be done by operation, since the base of the skull is sure to be gravely affected. If treatment is attempted, one or other of the many plans for exploring the nose or naso-pharynx must be resorted to, and the operative measures must be modified according to the peculiar requirements of the case. Probably total ablation of the superior maxilla will give the best approach to the mass.

Other forms of **Malignant Disease of the Nose** are met with, and may originate in any part of the nasal fossæ. **Squamous epithelioma** is that which occurs most frequently, the symptoms consist in the presence of a blood stained discharge, and a certain amount of respiratory obstruction, together with pain and cachexia. The lymphatic glands at the angle of the jaw are early enlarged, and the course of the disease is usually rapid owing to the great vascularity of the part. Up to within quite a recent period such growths have been almost always looked on as inoperable, but within the last ten years attempts have been made to remove them, and although necessarily the mortality is great, and the liability to recurrence considerable, yet the results have been such as to encourage the practice of attacking the disease, even in such a difficult region to explore as the interior of the nose.

**Sarcoma** may also commence in the nose itself, quite apart from that which originates in the superior maxilla. It gives rise to the usual signs of an intranasal growth, and may be dealt with in a

satisfactory manner by local means, such as curetting and the application of caustics. Not a few cases are on record in which such treatment has proved efficacious in curing the disease.

The operations which have been devised for dealing with disease of the nose and naso-pharynx are so numerous and complicated that it is impossible for us to mention more than a few of the most useful and important.

(a) In many cases of intranasal disease considerable assistance can be derived by opening up the anterior nares, especially when one is operating for caries or necrosis of the turbinated bones. It may suffice merely to divide one ala nasi and the attachments of the cartilages to the maxilla, but where both sides are involved *Rouge's operation* is advisable. This consists in the detachment of the mask of the face from the maxilla by everting the upper lip and incising the mucous membrane and subjacent tissues until the nasal cavities are opened. The septum nasi is divided by cutting pliers, and the nasal cartilages are completely separated. The soft tissues of the face can then be retracted upwards, and the nasal fossæ fully exposed. The bleeding is always considerable, and the space gained in children is but slight. When the operation is completed, the mask of the face is allowed to fall back again into position union occurring without difficulty, although no sutures are employed.

When the upper and anterior portion of the nasal cavity is to be dealt with, *Langenbeck's plan* can sometimes be utilized with advantage. An incision down to the bones is made along the outer border of the nose from the root downwards and outwards towards the ala. The soft parts are retracted on either side so as to expose the nasal bone and the nasal process of the superior maxilla, a wedge-shaped portion of which can be divided by cutting pliers and prised upwards but left with their superior connections untouched, so that after the operation they can be replaced.

When the septum alone is involved in malignant disease, it is possible to deal with it by an operation, which consists in splitting the upper lip in the middle line and carrying the incision round the ala nasi on each side so that the lower portion of the nose can be turned upwards after dividing the septum. A wedge-shaped portion is then removed from the front of the palate after detaching the muco-periosteum from its buccal aspect. An excellent approach is thus obtained into the nasal cavity, and the entire septum can in this way be removed without difficulty. The parts can be afterwards brought together quite naturally, and the deformity is very slight.\*

(b) When the disease is located further back, originating rather in the naso-pharynx than in the nose itself, the *palatine route* may be used with advantage. Perhaps the best of the several suggested operations is that of *Nelaton*. This consists in a median section of the velum and of the mucous membrane covering the posterior half of the hard palate. A transverse incision is then made on either side of the anterior extremity of this, and two muco-periosteal flaps are reflected, exposing a quadrilateral area of bone which is removed by chisel and mallet. If need be part of the vomer is also taken away, and thus the naso-pharynx is opened sufficiently to allow of the removal of the polypus or growth. The reflected segments of the palate are subsequently sutured together.

(c) Various methods of *osteoplastic section of the superior maxilla* have been practised, and *Langenbeck's name* has been associated with one or two different plans, which are, however, only suited to particular cases of disease, and at best give but poor access to the parts behind or above the superior maxilla, whilst they usually leave extremely ugly cicatrices. Perhaps the best plan to adopt is to detach the superior maxilla temporarily from its bed, turning it outwards together with the cutaneous and subcutaneous tissues overlying it, and then, after completing the operation, replacing the bone and suturing the soft parts into position. The results of such practice have been encouraging.

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\* A patient on whom this operation was performed eight years ago for undoubted epithelioma of the septum reported himself at hospital whilst this edition was in the press, he was quite free from recurrence, and apart from a sunken bridge to his nose, there was no deformity.

**Adenoids** — It has been already mentioned that the naso-pharynx is the seat of a large amount of lymphoid tissue, similar to that met with in the tonsil, which may either be distributed widely over the whole mucous membrane, or be gathered into a special mass on the roof, known as the pharyngeal or Luschka's tonsil. Adenoids consist in a hyperplasia of this tissue, exactly analogous to the chronic hypertrophic form of tonsillitis, with which, indeed, it is often associated. They usually occur in the form of broad, cushion-like masses springing mainly from the roof or posterior walls, or occasionally as pedunculated tumours hanging down into the posterior nares. The tumours are



FIG 308 — ADENOID FACIES (FROM A PHOTOGRAPH KINDLY LENT BY DR ST CLAIR THOMSON)

This illustration shows well the sleepy look, the pinched nostrils, the open mouth and projecting upper central incisors, so characteristic of this condition.

extremely soft and vascular, bleeding very readily. The surface is often plicated, and in the recesses or folds between the different portions of the mass bacteria lodge and give rise to various inflammatory troubles, both locally and in neighbouring lymphatic glands. Not uncommonly isolated masses similar in structure to the above are also to be seen on the posterior wall of the pharynx, and a certain amount of chronic rhinitis and laryngitis may be associated. The condition is rarely seen in others than children, and especially in those living in the smoky atmosphere of large towns. If untreated, they usually atrophy in time, but not before much harm may have been done to the individual.

The **Symptoms** are mainly due to obstruction to nasal respiration. The mouth is generally held half open, so as to allow the child to breathe through it, thereby exposing the upper central incisors (Fig 308), for a similar cause he snores during sleep, and usually wakes with the mouth and tongue dry. The nostrils are drawn in, and the nose thin and pinched, the whole aspect being very characteristic, the children often look sleepy and half silly, and indeed may be very backward in their studies. Not uncommonly there is a certain amount of semi-purulent discharge from the nose, or it may be

hawked up from the pharynx, perhaps mixed with blood. Acute or chronic otitis media results from extension of the catarrhal condition to the mucous lining of the Eustachian tubes, and deafness may be thereby induced, both taste and smell are sometimes impaired. The palate becomes high and arched, owing to the defective intranasal air pressure, and as the patient grows up, the incisor teeth may project forwards, giving a curious rabbit like expression to the face. The cervical glands are sympathetically enlarged, and often the seat of tuberculous disease. In bad cases which have been allowed to persist throughout adolescence the thorax becomes flattened owing to the inability of the child to take a really deep inspiration, the ribs are drawn in, and the spine is kyphotic (Fig 309).

**Physical Examination** consists in posterior rhinoscopy, by means of which the growths can be seen, or in palpation of the posterior nares, a process more suitable to children, who rarely have sufficient control to permit of the former. On passing the finger behind the velum, the naso-pharynx is found to be occupied by a soft mass of tissue which readily bleeds, and more or less obstructs the openings of the posterior nares.

**Treatment** consists in the great majority of cases in removal of the adenoids by operation. In mild cases, however, much may be done by enforcing respiratory exercises with the mouth shut, and in young adults attention to the general health, combined with irrigation of the nose with salt and water, and perhaps the local application of a weak solution of nitrate of silver (5 grains to 1 ounce) to the naso-pharynx, may suffice to bring about improvement.

**Operation**—Some diversity of opinion exists as to the character and extent of the operation, some authorities consider that all that is required is to scrape the growths away with the finger-nail, and undertake this proceeding either under nitrous oxide gas, or even without an anæsthetic. Such a measure is, to our minds, unsatisfactory, in that the adenoids cannot possibly be entirely removed, and recurrence may ensue. As a general rule, the child should be anæsthetized with chloroform, and the head may be allowed to hang



FIG 309.—LATERAL VIEW OF A CHILD WITH NEGLECTED ADENOID. (FROM A PHOTOGRAPH LENT BY DR ST CLAIR THOMSON.)

This is the same child whose face appears in Fig 308. It will be seen that the chest is shallow and retracted, and the spine kyphotic. The arms are small, but the legs are well developed.

backwards over the end of the table. If enlarged tonsils co exist, these should be dealt with in the first place. Gottstein's curette or some modification of it is then introduced behind the soft palate, the velum being drawn forwards by the left index finger. It is pressed upwards so that its free convex edge impinges on the upper part of the posterior border of the nasal septum. It is then swept backwards and downwards over the pharyngeal wall, so as to shave away the chief portion of the projecting mass of adenoids. Possibly the application of a second smaller curette may be required to deal with outlying lateral portions of the mass, and finally the adenoid tissue about the orifices of the Eustachian tubes and any remaining tags are removed by the use of Lowenberg's forceps or the finger-nail. Of course, there is considerable bleeding, but this quickly stops of itself, as soon as the operation is over, the child should be turned over and held face downwards, so as to allow the blood to run out of the mouth and nose, whilst the face and forehead are sponged with ice cold water to check the hæmorrhage. The patient is kept indoors for a few days, and only fluid food allowed. No local after-treatment is required as a rule, but the throat may be gargled or the nose washed out with weak salt and water. Nose-breathing exercises should be subsequently instituted.

**Epistaxis**, or bleeding from the nose, may arise from a variety of causes, including traumatism, directed either to the mucous membranes or the bones, or from the presence of ulceration or tumours. Some of these local causes are very evident, if only they are carefully looked for with a rhinoscope and frontal mirror. One of the commonest lesions is a small abrasion or ulcer of the septum, due to detaching by the finger a scab or dried crust of mucus which causes irritation within the nostril, each time the nose is 'picked' in this way, bleeding recurs. Another frequent source of epistaxis is the rupture of a varicose vein in the mucous membrane of the septum, varix occurs not unusually in plethoric individuals, and sneezing or blowing the nose violently may lead to an attack. Foreign bodies may also cause hæmorrhage, as also ulceration of an angioma on the septum. It frequently occurs in young people about puberty in consequence of local disturbance in the vascular arrangement of the parts, again, cerebral congestion may induce it, owing to the communication by means of emissary veins between the interior of the skull and the venous plexuses in the nose, excessive changes in the atmospheric pressure, as in mountaineering, may lead to epistaxis, whilst in abnormal states of the blood it may be associated with hæmorrhage elsewhere, as in hæmophilia, purpura, and scurvy. One or both nostrils may be the seat of the bleeding, and it may be so excessive as even to threaten life.

**Treatment**—It must not be forgotten that, in the majority of cases, there is some local cause of epistaxis which can be found and treated directly—a fact which once more emphasizes the necessity for gaining a mastery over the use of the rhinoscope. The bleeding is generally unilateral, and in nine out of ten cases the source is within easy

reach of the anterior nares, and hence in many instances all that is required is to grasp the nostrils firmly, and thus allow the blood to collect within, and give it an opportunity of clotting. At the same time, the patient should sit up, and cold be applied to the root of the nose, or to the nape of the neck. If on examination the bleeding-point is detected, whether it be a varicose vein or an ulcerated surface, the hæmorrhage can almost at once be stayed by applying a pointed galvano-cautery, or by sealing the spot with a swab soaked in a solution of chromic acid. Failing these measures, the nostrils may need to be plugged, but such a proceeding ought to be seldom resorted to, it is practically a confession of want of skill in the use of the rhinoscope. It may suffice merely to stuff the anterior nares with long strips of boric lint, but, as a rule, the posterior nares also require plugging. For this purpose Bellocq's sound (Fig 310) is usually employed in order to pass a thread round the base of the palate, and out of both nose and mouth, but where it is not obtainable, a suitably curved pair of laryngeal forceps or a catheter may be used instead. To the lower end of this thread a pledget of lint about

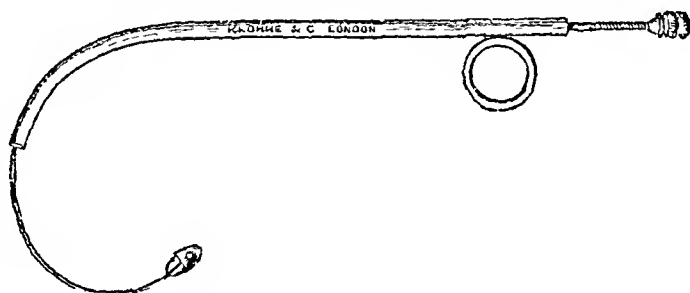


FIG 310 —BELLOCQ'S SOUND

$1\frac{1}{2}$  inches by 1 inch in size is attached, and this, guided by the finger round the soft palate, is drawn tightly forwards into the posterior nares. It is a good plan to have two threads coming forwards out of the nose, and these may be tied firmly around a pad of lint placed over the side of the nostril, thereby occluding the anterior nares and completely blocking the nasal cavity, back and front. The loose end of the thread emerging from the mouth is fixed to the cheek by a strip of adhesive plaster. The plug is retained for twelve hours, and then removed, and the nasal fossæ irrigated with a weak warm alkaline antiseptic lotion in order to prevent sepsis.

Another method of arresting epistaxis is by Cooper Rose's inflating plug, it consists of a piece of gum catheter, surrounded by a thin indiarubber bag, which can be inflated through the hollow stem. It is oiled and passed well into the nose from the front, the indiarubber bag is then inflated to the required extent, the air being retained by a stop-cock. This generally acts most efficiently, and can be introduced and removed with scarcely any pain to the patient.



## CHAPTER XXIX

### AFFECTIONS OF THE MOUTH, THROAT, AND ŒSOPHAGUS

**Stomatitis**, or inflammation of the mucous membrane of the mouth, is by no means uncommon, especially in children

1 **Simple Catarrhal Stomatitis** results from mechanical irritants, such as roughened teeth, from irritating chemicals, or from that septic form of inflammation which is so liable to follow operations involving the mouth. It may also arise in the course of fevers, and in conditions of debility such as follow measles and other exanthemata in children, or be associated with disturbances in the alimentary canal, as by improper feeding, dyspepsia, etc. The mucous membrane becomes hyperæmic and swollen, usually in small localized patches, which may gradually spread and become confluent, involving nearly the whole of the oral cavity. The exudation of mucus is increased, and becomes viscid and turbid, whilst the epithelium, at first white and sodden, is after a while rubbed off, leaving superficial erosions or distinct ulcers, which are very painful. The *treatment* consists in the removal of all sources of irritation, and the administration of drugs to correct intestinal derangements. Chlorate of potash, possibly combined with dilute hydrochloric acid, is very useful, both locally and internally. In the more severe cases antiseptic mouth-washes should be employed, such as the liquor sodæ chlorinatæ (1 ounce to 1 pint of water), sanitas (1 in 10), boro-glyceride (1 in 20), etc.

2 **Aphthous Stomatitis** occurs in badly-fed children, in the form of small whitish spots on a hyperæmic base, which run together, and produce ulceration. Attention must be directed to the general condition, and a little borax and honey or a solution of boro glyceride (1 in 20) applied locally.

3 **Thrush** is a very similar condition, but due to the presence of a parasitic fungus, the *Oidium albicans*. It occurs in patches somewhat resembling curdled milk in appearance, and requires the same treatment. In both these types there is often considerable enlargement of the lymphatic glands, which, however, frequently subside without suppuration on removal of the cause.

4 **Gangrenous Stomatitis** is much the same in origin as the preceding, but more acute in its course. It occurs in debilitated children

or elderly people, the subjects of albuminuria or diabetes, and is usually due to foul and dirty teeth. The gums and adjacent tissues become gangrenous, and severe toxic symptoms result. Active treatment by scraping and the use of antiseptics, such as peroxide of hydrogen, is urgently necessary.

In children this condition is known as *Cancrum oris* (p 109).

5 **Mercurial Stomatitis** may arise during the administration of a course of mercury, or occasionally from a single dose in persons who are sensitive to its action. It is increased in severity if the mouth and teeth are dirty, or if the patient smokes to excess. The gums are swollen and tender, bleed on pressure, and are very painful, especially when biting, or drinking hot fluids. The teeth may become loose and fall out, whilst the alveolar borders may be laid bare and necrose. The tongue is sometimes swollen and inflamed, salivation is a marked symptom, and the breath becomes very offensive. *Treatment*—Either leave off the mercury, or at any rate reduce the dose considerably, and administer saline purgatives. Chlorate of potash, combined with alum, dilute hydrochloric acid, or tincture of myrrh, may be useful locally.

6 For **Syphilitic Stomatitis**, see p 143.

The buccal mucous membrane is also involved in the course of other diseases, *e.g.*, diphtheria, scarlet fever, and erysipelas, but special descriptions are not needed here.

### Affections of the Tongue

**Congenital Abnormalities**—(a) The tongue has been entirely absent. (b) One half of the tongue is defective in size (*hemiatrophy*). (c) *Tongue-tie* is said to be present when the frænum is shorter than usual, causing the tip to be depressed and fixed in the floor of the mouth so that it cannot be protruded. Sucking becomes difficult in such a condition, and when it is allowed to persist, there is often a lisp in the speech. Treatment is only needed in the severer forms, and consists in raising the tongue with the index and middle fingers placed one on either side, and snipping the frænum, thus put on the stretch, across its centre with a pair of blunt-pointed scissors directed downwards. (d) The tongue may be adherent to the floor of the mouth, being *bound down* by folds of mucous membrane (*ankyloglossia*). This may also exist as an acquired condition due to cicatricial contraction after ulceration. In congenital cases the adhesions are but slight, and the organ can be readily freed, in the acquired condition this cannot always be accomplished. (e) The frænum and tongue are occasionally too long, allowing of increased mobility, and even fatal results have occurred from the organ rolling backwards and impeding respiration. (f) The tongue may be *cleft*, presenting a bifid appearance, this may be complete or partial, and is usually associated with a congenital fissure through the lower lip and mandible. (g) *Macroglossia* (or large tongue), although sometimes acquired, is usually a congenital deformity. The organ is enlarged

in all directions, and protrudes from the mouth, so that the teeth indent it, and cause ulceration and considerable interference with the venous return. It thus becomes purplish and dry from exposure, the mucous membrane looking almost like skin, although saliva dribbles freely from beneath it. In old-standing cases the teeth are displaced outwards and the jaws deformed, so that, even if the tongue is reduced to its normal size by treatment, it may be impossible to close the mouth. Pathologically, it is due to diffuse overgrowth of the connective tissue, secondary to lymphatic obstruction and dilatation. Recurrent attacks of lymphangitis add to the trouble, the tongue gradually increasing in size, and the disease has been known to terminate in the development of a lympho-sarcoma. The *treatment* consists in excision of a V-shaped portion, suturing the raw surfaces subsequently with catgut.

**Wounds** of the tongue are usually caused by the teeth, especially during an epileptic seizure, or in children as a result of falls with the tongue out. There is often brisk hæmorrhage for a few moments, which soon ceases, though blood may be extravasated into its substance, and cause considerable swelling. In simple cases the wound should be examined and purified, and the mouth constantly cleansed with mild antiseptic lotions, a few points of suture may also be inserted if necessary, but the wound must not be entirely closed, or tension from sepsis will result. When smart arterial bleeding is present, the mouth must be opened, the tongue pulled forwards, and the wounded vessel sought for and tied. Failing this, the lingual artery may be tied in the neck, or even the external carotid.

**Acute Superficial Glossitis** occurs as part of a general stomatitis, and needs no special notice.

**Acute Parenchymatous Glossitis**, or acute inflammation of the tongue, may arise from penetrating and, of necessity, septic wounds, or from the bites or stings of insects, or may be associated with acute stomatitis in the course of fevers, but is most commonly due to the injudicious administration of mercury. The condition may be limited to one half of the organ, but when arising from general causes is bilateral. The tongue becomes painful, swells up rapidly so as to fill the mouth, and even protrudes beyond the teeth, the pressure of which leads to superficial ulceration. The salivary glands are enlarged and painful, and salivation is a marked feature in the case. Speech, swallowing, and even respiration are much interfered with, and there may be considerable febrile disturbance. The case, if treated with care, usually ends in resolution, but diffuse or localized suppuration may ensue, as well as the most urgent dyspnoea, arising either from œdema glottidis or from the pressure of the enlarged organ. *Treatment* consists in stopping the mercury, or removing any evident cause, and in the administration of saline purgatives with chlorate of potash. Leeches may be applied beneath the angles of the jaw, but in bad cases a free incision into the dorsum should be made on either side of the median line to give exit to the effused fluids and blood. The most rapid relief to the symptoms is thereby obtained,

although the organ may remain enlarged for some time. If asphyxia is threatening, high tracheotomy or laryngotomy is required.

Abscess of the tongue may result from the acute process described above, but is more usually of a chronic nature, and situated at the anterior part of the organ. It is generally due to the admission of micro-organisms through some superficial lesion which has quickly healed. It presents as a tense swelling, fluctuation in which may be masked by the amount of inflammatory thickening which surrounds it. A free incision both settles the diagnosis and cures the case.

**Chronic Superficial Glossitis** is an interesting and important disease, which may be associated with a similar condition of the mucous membrane lining the interior of the cheeks and lips. It is most commonly due to syphilis, occurring as a tertiary phenomenon, but may arise from excessive smoking, ragged and rough teeth, or spirit-drinking, chronic dyspepsia, perhaps of a gouty nature, being also present in many cases. It is very liable to be followed by epithelioma, Barker stating that out of 110 cases he carefully investigated cancer occurred in 43.

For purposes of description it is useful to divide the disease into the following five stages, although it must be clearly understood that they are artificial, and several of them may be present in different parts of the same tongue. (i) The papillæ become enlarged and swollen, leading to the appearance of red hyperæmic patches, which cannot be recognised for certain unless the tongue is thoroughly dried with a handkerchief, towel, or piece of clean blotting-paper, which must not be carelessly dabbed over the organ, but should be firmly pressed down upon it so as to absorb all the moisture. (ii) Overgrowth of epithelium follows, and as it increases in thickness, it becomes opaque and horny, so that the red patches are replaced by white ones, leading to the appearance which has been designated *Leucoplakia*. Sometimes the papillæ become much enlarged, and stand out definitely and separately from the organ, or the whole surface may be covered with dense white patches. To this condition the term *Ichthyosis* has been applied. (iii) Later on, the excess of epithelium is shed, leaving red smooth patches in which the papillæ are atrophied, or have entirely disappeared. If this occurs over the greater part of the organ, the *glazed red tongue* so characteristic of tertiary syphilis is produced. If, however, this process only occurs in smaller areas intermixed with portions covered with white epithelium, a patchy appearance of the tongue results, wrongly termed *Psoriasis linguae*. (iv) At varying periods of the disease, sometimes earlier, sometimes later, the organ becomes ulcerated, *cracked*, or *fissured* in a somewhat characteristic manner. A median fissure is usually seen running down the middle, and from this furrows extend transversely, dividing the surface into rectangular compartments. These fissures are not always due to the cicatrization of cracks, as when opened out healthy papillæ are seen at the base, and no sign of superficial scarring. They are, then, evidently the result of the contraction of deep sclerosed tissue in the substance of

the organ Superficial ulceration often occurs, apart from these fissures, being probably due to some local irritation, or to smoking, the atrophic condition of the mucous membrane explains the great liability to this occurrence (v) Still later, epithelioma may develop, and usually in connection with one of the cracks, or of the cicatrices arising therefrom It is often somewhat slow in its progress, owing to the amount of sclerosis induced by the preceding inflammation The typical *smoker's patch* is a red irritable area on the front of the tongue, from which papillæ are often absent, and perhaps covered with a yellowish-white crust Sometimes the epithelium is heaped up here into a well-marked leucoplakic spot

All these stages of the disease are accompanied with much discomfort, the tongue being sometimes so tender that the patient cannot drink hot fluids or take condiments or stimulants without pain The speech, too, is interfered with, becoming thick and indistinct The course of the case varies considerably, and if cancer does not follow, the affection usually settles down after a time, and causes but little discomfort, so long as the patient conforms to the restrictions as to diet, etc., which are essential

The *treatment* of the case is usually a matter of some difficulty All sources of irritation are excluded from the mouth as a first precaution Thus, smoking or chewing tobacco must be rigidly prohibited Spirit-drinking and all acid wines which cause pain should be forbidden, dilute whisky and water being perhaps the best stimulant The teeth must be well brushed night and morning, and all stumps and rough excrescences removed Condiments, such as mustard, spices, curry, and cheese, are excluded from the dietary, and only simple unirritating ingesta allowed The mouth is washed out frequently with an alkaline lotion, *e.g.*, bicarbonate of soda (20 grains to 1 ounce), or borax (10 grains to 1 ounce), especially after meals, so as to exclude all risk of acid fermentation in the debris of food Cracks and sores are treated by painting the surface with a solution of chromic acid (grs v ad  $\bar{3}$  i) or of perchloride of mercury (grs ii ad  $\bar{3}$  i) Solid nitrate of silver should be avoided, as Mr Butlin points out its use is likely to predispose to epithelioma

General antisyphilitic remedies are employed where necessary, the digestion is attended to, and if the new formation of epithelium is excessive, arsenic may be administered

On the appearance of definite epithelioma suitable operative measures must be instituted, but it is perfectly justifiable to remove by operation irritable and infiltrated fissures and cracks, even before true cancer has appeared Any wart-like projections should also be excised early

Ulceration of the tongue arises from a variety of causes, and occurs in many different forms Thus, *irritable* ulcers are due to rough and carious teeth *Dyspeptic* ulcers are associated with gastric disturbances, they are usually located on the middle of the dorsum, and are often very painful It is sufficient to touch them with lunar caustic after dealing with the cause *Tuberculous* ulcers are not

common, and are always secondary to pulmonary or laryngeal phthisis, the organ being infected by the sputum. They commence in the form of a submucous abscess, which bursts and leaves a small painful sore, rarely situated on the posterior part of the organ, but chiefly at the sides or on the dorsum near the tip. Secondary abscesses form around and coalesce with the original ulcer. *Treatment* is chiefly needed on account of the pain and discomfort caused by them, it consists in cocainizing and scraping the sores, touching the base with pure carbolic acid, and dressing with iodoform. Applications of cocaine may also be made before meals, as a palliative measure where radical treatment is not undertaken on account of the extent of the pulmonary mischief. *Lupus* also attacks the tongue, but is very uncommon, and almost invariably secondary to a similar affection of the skin of the face. In a case under our care it appeared in the form of an irregular granulating surface surrounded by nodulated cicatricial tissue of an exceedingly dense character. The progress was very slow, owing to the amount of sclerosis present. Treatment consists in the application of the X rays or of radium, but in some cases it may be advisable to undertake a preliminary course of treatment by scraping and cauterization. *Syphilitic* and *cancerous* ulcerations are described below.

**Syphilitic Disease** of the tongue occurs in a variety of different forms. A *primary* sore presents a characteristic indolent and inactive surface, usually near the tip, with subjacent infiltration, and much chronic enlargement of the submental lymphatic glands, which, however, do not generally suppurate. In the *secondary* stage mucous tubercles, fissures, and ulcers form, and usually on the sides or near the tip. Occasionally one meets with a broad wart-like condyloma on the dorsum, which may be associated with longitudinal fissures, it is sometimes termed 'Hutchinson's wart'. In the *tertiary* period chronic superficial glossitis may develop, as also diffuse infiltration of the organ, or gummata.

**Gumma** of the tongue is not uncommon, occurring usually in patients under forty years of age, as a late tertiary phenomenon. It starts as a localized submucous or intramuscular infiltration near the median line, and generally towards the middle or posterior part. The swelling is at first hard and firm, but later on becomes soft and fluctuating, and in time the overlying mucous membrane, which was unaffected, yields, and gives exit to the characteristic contents. The ulcer thus produced is oval or round in shape, and deeply excavated, the base being constituted by a slough, looking like 'wet wash-leather'. There is but little induration either of the base or edges, and one of the most characteristic features is the fact that neither the floor of the mouth nor the base of the tongue is involved, so that the organ can be freely protruded, whilst deglutition and articulation are scarcely interfered with. The patient complains of little pain, and the submaxillary glands are only affected either as part of a general enlargement throughout the body, or from the local irritation.

The progress is slow, and the effect of antisyphilitic treatment very

decided, the gumma absorbing, or the ulcer, if present, healing readily, but leaving a localized area of sclerosis or a deep cicatrix, from which malignant disease may subsequently originate. In some cases a diffuse infiltration of the organ occurs, leading to a generalized sclerosis rather than to a localized gumma. The *treatment* consists in the administration of iodide of potassium with or without mercury, whilst the mouth is kept clean with a simple mouth-wash.

**Innocent Tumours** are not frequent in the tongue, papilloma, cysts, lipoma, and *nævi* being the chief varieties, and requiring no special treatment.

**Dermoid Cysts** also form within or under the tongue, originating usually in connection with the thyro-glossal duct (p 893).

**Cancer of the Tongue** occurs in the form of squamous epithelioma, and is both a frequent and a very fatal variety of this disease. It is usually met with in men, and may arise as a result of the irritation caused by excessive smoking, especially of cigars, cigarettes, or foul pipes.

Its mode of onset varies somewhat according to the situation. (a) It arises most commonly as an ulcer at the margin of the organ, towards the junction of the middle and posterior thirds, and is then probably due to the irritation caused by ragged and irregular bicuspid or molar teeth, (b) it may start in a crack, fissure, or cicatrix on the dorsum, as a result of chronic superficial glossitis, or of a preceding gumma, (c) it may commence as a wart-like growth, the base of which becomes infiltrated, the tumour invading the muscular substance, and spreading to the root of the tongue, (d) it may originate as a submucous infiltration, starting as an ingrowth from the mucous membrane, without much external manifestation of its presence, (e) it may first be noticed as an irregular ulcer in the floor of the mouth, or (f) it may spread into the tongue from surrounding parts, such as the tonsil or larynx.

In whatever way it starts, the same features are soon manifested, viz, a new growth is noticed, hard in consistence, indefinite in its extent, which may or may not be painful from the first, and which ulcerates superficially, exposing a more or less crateriform cavity, with a gray, sloughy, foul surface, readily bleeding when touched, and discharging a foul secretion, which causes extreme fœtor of the breath. The ulcer is surrounded by an indurated mass, which gradually shelves off into the neighbouring healthy structures, or may be abruptly limited. Profuse salivation is produced by the irritation of the branches of the third division of the trigeminal, and all the movements of the tongue are painful and limited on account of the infiltration of the base, so that both swallowing and speech are difficult, the patient allowing the saliva to dribble out of his mouth. The pain is often very excessive, and usually extends along many of the branches of the fifth nerve, especially to the ear, so that sleep becomes impossible, and the patient's condition steadily and rapidly deteriorates. The glands under the chin and at the angle of the jaw early become involved in the disease, which ultimately attacks

the deep glands in the neck. These secondary growths are very frequently cystic in character from the degeneration of the masses of epithelium formed within them. After a time they approach the surface and burst, leaving ragged malignant ulcers in the neck. The lower jaw, moreover, is often invaded in the later stages of the disease.

The occurrence of the typical cachexia is determined not only by the pain and consequent sleeplessness but also by the inability to take sufficient nourishment, the absorption of products of putrefaction swallowed with the saliva, the excessive salivation, the occasional hæmorrhages, and the extent of the secondary growths. The patient rarely lasts apart from treatment for more than twelve months after the disease has been first noticed.

**Diagnosis.**—When a case is met with where the ulcer is situated at the side or base of the tongue in a patient over forty-five years of age with the typical enlargement of the glands, profuse salivation and impaired movements, there can be little doubt as to the diagnosis. But when it is seen in the early stage as an infiltration of a syphilitic fissure or cicatrix or as a small wart it may be difficult to determine whether or not malignant disease is present. The early enlargement of the glands, the amount and character of pain, the fixity of the organ, and the infiltration of the base of the ulcer are important guiding marks; but in doubtful cases a small portion of the growth should be excised under cocaine and subjected to careful microscopic examination and thus its nature ascertained. Moreover, the administration of steadily increasing doses of iodide of potassium will generally bring about rapid improvement in a syphilitic case but will do no good to an epithelioma except perhaps temporarily when the two diseases co-exist.

**Treatment.**—The only hope of curing the patient lies in thorough and early removal of the growth, which it must be remembered has probably extended much further than one expects. Hence no half-measures should be adopted, but complete operations including also the lymphatic area, are desirable. For practical purposes the cases may be divided into two groups—those in which the disease is limited to one portion of the tongue, and the muscular tissue is not extensively invaded, and those in which glands or other structures are also obviously involved, or the tongue itself is widely infiltrated. In the first class of cases a simple intra-buccal operation will often suffice, combined with separate removal of the glands; in the second, more extensive procedures are required.

In all cases great care must be taken in the preparation of the patient so as to minimize the risk of septic contamination. The mouth is often very foul and must be dealt with by removing all septic roots of teeth, cleansing thoroughly the teeth that remain, and using frequent antiseptic mouth-washes. Antistreptococcic serum (of the polyvalent type) may also be utilized as a preliminary measure in order to diminish the likelihood of septic troubles: three or four injections of 10 c.c. each are made on the day preceding the



operation, and perhaps one or two afterwards. The results obtained in this way have been satisfactory.

The Intrabuccal Method now adopted for *partial removal* of the organ is that known as Whitehead's Operation. The lingual artery should always be previously secured in the neck (p. 330), thus giving the surgeon an opportunity of clearing the submaxillary region, this should include the removal of the submaxillary and submental lymphatic glands, as well as those lying over the external carotid artery, and it is always wise to include the submaxillary salivary gland. No half-measures are allowable, but a wide and sweeping dissection is required. The mouth is then well opened with an efficient gag, and chloroform-administered by means of Junker's apparatus. A good assistant is necessary in order to prevent blood entering the larynx, small swabs or pieces of sponge held in smooth-nosed, long-handled forceps or suitable sponge-holders being used to clear the pharynx. A coarse silk thread is passed through each half of the tongue to draw it forwards and steady it. The tongue, being drawn out of the mouth by these loops of silk, is carefully divided by blunt-pointed straight scissors down the middle line into two segments, which are readily separated from one another by the finger, the scissors merely dividing the mucous membrane. The base of the organ is freed by cutting through the line of attachment of the mucous membrane to the alveolus, and then along the middle line of the floor of the mouth from the tip of the tongue, so that the sublingual salivary gland can be also taken away—a most necessary step. The mucous lining of the dorsum is now divided transversely behind the growth, and the muscular structure of the organ slowly snipped through with scissors, during this process, by the aid of the finger or a director, the vessels and nerves can be seen and recognised before division. Removal of the diseased half with the sublingual gland is thus easily accomplished by making the incisions meet, and dividing the intervening tissues. Bleeding-points are picked up and secured as they appear.

If the *tip* is alone involved, it can be removed by a V-shaped incision, made after steadying the tongue with a deep suture. The small ranine artery will spurt on each side, but is easily secured, and the gap closed by catgut sutures.

If the *whole tongue* is to be excised, or even when one side alone needs removal as far back as the epiglottis or hyoid bone, a more extensive operation is necessary, and up to a recent date the *extrabuccal method* recommended by Kocher was chiefly utilized. A preliminary tracheotomy was usually associated with it. An incision (Fig. 300, C) is made, commencing close to the lobule of the ear, running down along the anterior border of the sterno-mastoid to the great cornu of the hyoid bone, and thence forwards nearly to the middle line, and upwards to the symphysis. This flap of skin and subcutaneous tissue is dissected up, and stitched to the cheek out of harm's way. All the lymphatic glands in the region—the submental, submaxillary, and those lying over the carotid—are now removed, as well as the submaxillary salivary gland, the lingual and facial arteries being tied close to the

carotid Any diseased portion of the jaw is isolated by saw cuts in front and behind, and removed Where only half the tongue is to be removed, it is now split down the middle line with scissors, and the mucous membrane in the floor and side of the mouth divided so as to leave that side of the tongue attached merely by the muscular structures If the whole organ is to be removed, it is unnecessary to divide it in the middle line By detaching the mylo-hyoid from the bone a communication is made between the outside wound and the mouth, and the tongue is then drawn through this lateral opening, and can be removed as far back as the epiglottis behind and the hyoid bone below, the whole floor of the mouth being effectually dealt with in this way The external incision is closed by a continuous suture a large drain-tube being inserted at the lowest point for a few days

It is obvious that such an operation is not devoid of serious risks from sepsis, since a deep and extensive dissection of the neck after exposing freely the main vessels is brought into direct communication with the cavity of the mouth, which is often exceedingly foul The death-rate has not been insignificant, and hence Kocher himself has returned to the method formerly recommended by *Syme*. An incision is made in the middle line dividing the lower lip, extending downwards to the hyoid bone The mandible is sawn through in the middle, and the two halves separated widely As much of the tongue as is considered necessary can be easily removed by the scissors The mucous membrane is divided close to the alveolus laterally, the anterior pillars of the fauces are snipped across posteriorly, and the floor of the mouth is dissected up The lingual vessels can usually be secured before division After securing hæmostasis, a silk thread or silver wire is passed through the stump of the tongue and epiglottis in order to control it and prevent interference with respiration, the halves of the jaw are wired together, and the superficial wound closed

In this procedure preliminary tracheotomy is not required as a rule, and the glands are dealt with subsequently as soon as the mouth wound has begun to heal, *i.e.*, in a week or ten days' time

The ~~After-Treatment~~ is much the same in all cases The raw surface may be painted with Whitehead's varnish (which consists of Friar's balsam, but with the rectified spirit replaced by a saturated solution of iodoform in ether), but the all-essential thing is to keep the cavity well washed out with antiseptic lotions, such as weak solutions of boric acid, boroglyceride (1 in 20), santal, or lysoform The patient must be closely watched for the first forty-eight hours, to see that his respiration is not obstructed by the stump of the tongue falling backwards but at the end of that time this danger will be at an end, and the silk or silver wire may be removed The patient is fed *per rectum* for twenty-four hours, but afterwards a tube attached to the spout of a feeder is introduced into the pharynx or Œsophagus In the simpler cases he is able to swallow freely and

\* Kocher's Textbook of Operative Surgery, p. 109. Translated from the fourth German edition by Harold J. Stiles, M.B., F.R.C.S. London: Adam and Charles Black, 1903.

without difficulty in the course of a day or two, and even in the worst cases he can feed himself with a long tube passed into the pharynx in five or six days. The chief dangers of the operation arise from septic contamination, resulting in secondary hæmorrhage or septic pneumonia, and these are best avoided by careful attention to the preparation of the patient before operation.

**Preliminary Tracheotomy** is sometimes employed in operations on the tongue, but is scarcely required except when Kocher's original operation is undertaken. A Hahn's trachea-tube (*ie*, a large one surrounded with compressed sponge infiltrated with iodoform, which will expand and absolutely shut off the lower respiratory tract from the mouth) is inserted, or a Trendelenburg's air tampon, or an ordinary tube may be employed if the pharynx is well packed with a sponge so as to prevent blood trickling downwards, the anæsthetic can then be administered through the tube. The advantages of this method of treatment are threefold: (*a*) The patient can be kept in a condition of complete anæsthesia without hindrance to the surgeon, so that the operation is more quickly finished, the shock is less, and the removal of the disease can be more thoroughly accomplished; (*b*) the patient runs no danger of asphyxia during the operation by blood trickling into the lungs, or by fragments of tissue or sponge getting loose in the mouth and being inhaled, whilst later on falling back of the root of the tongue does no harm; and (*c*) the chances of septic pneumonia are reduced to a minimum. Of course, opening the trachea is not entirely devoid of danger, and therefore this plan should not be adopted unnecessarily.

The removal of a part, or even the whole, of the tongue is not such a mutilation physiologically as one might expect at first. Deglutition is interfered with for a time, but the power is soon regained, and even articulation may be in great measure restored.

### Affections of the Floor of the Mouth

**Sublingual Abscess**, when acute, is due to infection of the submucous tissue, as by puncture with a fishbone, or starts in a follicle of the sublingual or in a submucous gland. The inflammation which follows results in the formation of a puffy swelling beneath the tongue, which, if not opened early, may lead to an extension downwards of the mischief into the submental region. The tongue becomes swollen and turgid from pressure upon the veins, whilst œdematous laryngitis may also be induced. Considerable constitutional disturbance generally accompanies this process. A median incision through the mucous membrane, and the insertion and opening of a pair of dressing forceps, is the safest and best method of treatment, the cavity being subsequently washed out and drained. The more diffuse form of sublingual abscess is usually associated with submaxillary cellulitis (p. 75).

The sublingual region is also a favourite site for **Actinomyces** (p. 171), which manifests itself as a diffuse brawny induration of the

tissues, progressing slowly, and not very tender. As it comes to the surface, the skin becomes red and dusky, and sooner or later a series of little pustules appear one after another with a typical yellowish apex. These burst and discharge a glutinous fluid containing the fungus, and if kept aseptic and allowed to heal, are followed by depressed and puckered cicatrices. The administration of gradually increasing doses of iodide of potassium usually suffices to bring about a cure.

**Cystic Swellings** are not uncommon about the floor of the mouth, and amongst them the following may be described.

(a) *Mucous Cysts* result from the distension of mucous glands, they form small translucent swellings, elastic and fluctuating. All that is needed is to open them, and remove the anterior wall.

(b) *Ranula* is a very similar condition, but larger and unilateral, containing a glairy mucoid fluid, and sometimes due to obstruction and distension of one of the sublingual ducts (or ducts of Rivini). A similar condition has been caused in rare cases by a blocking of Wharton's duct, but this has generally been found to run along the outer surface of the cyst. The tumour may be as large as a walnut or pigeon's egg. The *Treatment* consists in removing a good-sized piece of the wall so that the cavity may be obliterated by a process of granulation, or if that should fail, the whole cavity must be dissected out.

(c) *Dermoid Cysts* are frequently met with in the floor of the mouth, occupying the middle line, and also projecting into the neck beneath the chin. They are due to non-obliteration of the upper end of the thyro-glossal canal (p. 893). The contents are of the usual sebaceous type. Such tumours should never be dealt with from the mouth, as they extend deeply, and need to be carefully dissected out. A free opening must be made in the middle line under the chin, and, if feasible, the whole cyst removed unopened. If it gives way, the entire wall must be dealt with, or recurrence will certainly ensue.

### Affections of the Salivary Glands

**Inflammation of the Parotid Gland** is met with in several different forms.

1 **Epidemic Parotitis (Mumps)** is an acute specific disease usually seen in children, highly infectious in character, and generally epidemic. The period of incubation is about three weeks, and the attack itself consists in a slight febrile disturbance, associated with swelling of one or both parotid glands, one gland is attacked first, becoming enlarged and tender, whilst the other side is similarly affected in a day or two. Mastication becomes difficult, owing to the tension of the parts. The swelling, which lasts for about a week and then gradually subsides, extends below and in front of the ear, and the socia parotidis can be distinctly felt lying over the masseter, the submaxillary, sublingual, and neighbouring lymphatic glands are sometimes, but not frequently, enlarged. Suppuration is rare, but

in adults metastatic inflammation of the testes, mammae, or ovaries is not uncommon. This complication is generally unilateral, and thus, although atrophy of the testis commonly follows orchitis, sterility is not produced. *Treatment*—Keep the patient warm and quiet, and administer salines. In the later stages friction with stimulating liniments will hasten resolution. After the acute attack, the gland may remain enlarged for some time.

2 A **Simple Parotitis** occasionally results from exposure to cold or from injury, whilst the presence of a calculus in the duct leads to a chronic sclerosing inflammation. The symptoms consist of pain and swelling, together with a certain amount of constitutional disturbance. An extremely interesting phenomenon is the parotitis which follows injuries or diseases of the abdominal or pelvic viscera. This condition is not very unusual, as is evident by the fact that Stephen Paget has been able to collect 101 such cases. It was formerly attributed to pyæmia, but is now considered to be due to infection of a mild type from the mouth, owing to a septic state of the teeth induced by prolonged rectal feeding. In confirmation of this view is the fact that it has been seen in not a few cases of gastric ulcer, where the patient had been fed *per rectum* for some time. *Treatment* in these simple cases consists in the application of fomentations, perhaps medicated with belladonna.

3 **Suppurative Parotitis** is a much more serious condition. It may extend from the mouth along Stenson's duct, or supervene in the course of pyæmia, or as a sequela of some of the exanthemata, *e.g.*, scarlet or typhoid fevers. If the inflammation spreads up from the mouth, suppuration occurs primarily within the tubules, under other circumstances, pus forms in the interstitial tissues. The gland becomes much enlarged, with congestion and œdema of the overlying skin, and, owing to the tension of the fascia, exceedingly painful. For the same reason, pus cannot readily find its way to the surface, and hence is likely to burrow in various directions, *e.g.*, amongst the muscles of the neck, or even upwards and inwards towards the base of the skull, or to the cavity of the mouth, finding its way over the border of the superior constrictor (the so-called 'sinus of Morgagni'). The constitutional symptoms from toxic absorption are usually very severe. Owing to the fact that large veins and arteries pass through the parotid gland, pyæmic symptoms are not unlikely to supervene, and the prognosis is therefore somewhat serious.

**Diagnosis**—Inflammation of the lymphatic glands lying on the outer surface of the parotid closely simulates the above affections, but is distinguished from them by the fact that they are more superficial, and that the socia parotidis is not enlarged.

**Treatment**—In the early stages fomentations are employed, but as soon as there is any indication that suppuration has occurred, a free incision must be made, and the pus let out. Every precaution should be taken to prevent mischief to the facial nerve, and Hilton's method of operating may be advantageously employed, but in the more severe cases where the patient's life is threatened and the pus

is burrowing in all directions, the knife must be freely used regardless of anatomical considerations

Inflammation of the **submaxillary** and **sublingual** glands may arise in an exactly similar way, but no special description is called for. Occasionally, however, the process extends beyond the submaxillary gland to the neighbouring tissues, giving rise to what has already been described as submaxillary cellulitis, or Ludwig's angina (p 75)

**Obstruction to the Flow of Saliva** results from various causes, such as cicatricial contraction in the neighbourhood of the entrance of the ducts into the mouth, or from the presence of a *salivary calculus*, consisting of phosphate and carbonate of lime, and usually fusiform in shape

The chief **Symptom** of such obstruction is a painful enlargement of the gland during and after meals, which slowly passes away as the saliva finds its way past the block, if it persists for long, the gland becomes chronically enlarged, and its interstitial tissue increased in bulk, whilst a certain amount of peri-adenitis also follows. When a calculus is present, there is usually a considerable discharge of offensive muco-pus into the mouth. Where the obstruction is complete, a cyst may form, and if this is opened, or finds its way to the exterior and bursts, a salivary fistula results. The formation of salivary calculi is not very common in connection with the parotid gland, owing to the fact that the saliva excreted is limpid in character, whereas that arising from the submaxillary and sublingual glands is thick and mucoid

**Treatment**—In cases of simple obstruction, an attempt must be made to restore the natural exit, or to make an artificial one. If a calculus is present, it can usually be seen or felt at intervals projecting from the entrance of the duct, in such a case the duct must be incised, and the stone removed. Where, however, it is located in the substance of the submaxillary, total removal of the gland may be necessary.

**Tumours of the Parotid Gland** are of considerable interest, and may be simple or malignant

(a) The **Simple** parotid tumour is usually an *endothelioma*, in which, however, fibrous and adenoid tissue may occur. It usually commences near the surface in the endothelium lining the bloodvessels and lymph spaces, and, owing to a colloid or mucoid degeneration of the interstitial tissue, may simulate a chondroma or myxoma. The tumour feels hard, firm, and nodular, but areas of softening may be interspersed amongst the harder portions. The mass is situated



FIG 311 —PAROTID TUMOUR  
(TERGUSSEN)

between the jaw and the sterno-mastoid, accessory processes' also extending over the masseter in the region of the socia, and later on burrowing deeply between the mastoid bone and the styloid process, and beneath the ramus of the jaw (Fig 311) In the early stages the tumour is freely moveable on the deeper parts, as is also the skin over it, but subsequently the mass becomes fixed and adherent The growth is usually slow, and at first quite painless, and there is no tendency to invade lymphatic glands or produce cachexia Mastication is impaired in the later stages, but otherwise the subjective symptoms are of but slight importance, owing to the fact that the growth is superficial to the gland, and to the more important vessels

and nerves If allowed to persist, the growth will finally take on malignant characters True adenoma or fibroma of the parotid gland is occasionally observed



FIG 312 —MALIGNANT TUMOUR OF THE PAROTID GLAND

(b) **Malignant** tumours of the parotid (Fig 312) occur in the form of endothelioma, sarcoma, or carcinoma, and are not unfrequently grafted on to a simple tumour, the change of type being marked by increased rapidity of growth and greater pain The mass becomes more fixed, and signs of pressure upon the vessels and nerves develop, the facial nerve is very likely to be implicated, leading to paralysis of the face

Moreover, the skin becomes hyperæmic and often adherent to the tumour, and finally ulceration and even fungation may obtain Secondary deposits occur in the neighbouring lymphatic glands or in the viscera, and the patient soon passes into a state of malignant cachexia Carcinomatous tumours are less common than the sarcomata, but run a similar course The growth is an adenoid cancer, not unfrequently of the soft or encephaloid type, and neighbouring lymphatic glands are early invaded

The **Diagnosis** of simple parotid tumours from malignant growths is a matter of the greatest importance from a prognostic point of view, since simple tumours are distinctly encapsuled, and their removal, except in extreme cases, is not a matter of special difficulty, malignant disease is much more diffuse, rendering complete extirpation of the mass almost impracticable The distinction between the two forms is made by a consideration of the signs and symptoms considered above, attention being directed to the rate of growth, the condition of the skin and surrounding parts, the mobility or not of the neoplasm, and the general aspect of the patient, whilst associated

paralysis of the facial nerve is almost always characteristic of malignancy. The lymphatic glands lying on the surface of the parotid, when invaded by tubercle or by epithelioma secondary to some intrabuccal growth, may closely simulate a true parotid tumour, but are recognised by their more superficial position.

The **Treatment** is often a matter of some difficulty, owing to the important character of the surrounding tissues. Removal should only be attempted if the skin is not extensively involved, if the growth is moveable on the deeper parts, and if there is no evidence of secondary deposits. Even simple tumours become irremovable after a time on account of their deep connections and change of type, whilst it is seldom justifiable to touch malignant growths on account of their early and wide dissemination. *Simple* parotid tumours are dealt with either by making a vertical incision over the most prominent part of the mass, or by turning forwards a flap, exposing thereby the capsule, which is incised transversely, for although the facial nerve is generally beneath the growth, it occasionally runs superficial to it, or in its substance. After this has been accomplished, the tumour is often enucleated without much difficulty, but the surgeon must make certain that no deeper processes are left, or recurrence will inevitably follow. The hæmorrhage from the transverse facial and other arteries is free, but easily restrained. There is no need to remove redundant skin in these cases, as it quickly contracts.



FIG 313—SUBMAXILLARY TUMOUR (TILLMANN'S)

In dealing with early malignant disease *excision of the whole parotid gland* may be occasionally undertaken. It is accomplished through a vertical incision, or, if the skin is involved, by two crescentic ones. The gland is then gradually freed from its connections, care being taken, if possible, to keep outside its capsule. It is best to deal with the lower part first, securing with double ligatures the external carotid artery and temporo-facial vein. The mass is then drawn upwards and forwards, and its deep connections severed. The facial nerve is, of course, divided, and the patient must be warned before the operation of the necessarily resulting facial palsy. Recurrence is almost certain to follow. Removal of the angle of the jaw as a preliminary step has been recommended, since considerable space is gained thereby, and a better access to the field of operation.

**Tumours of the Submaxillary Gland** are very similar in nature to those of the parotid. Simple tumours are represented by endothe-



mata, resembling cartilaginous or myxomatous growths, according to whether they are hard or soft (Fig 313) Sarcoma and carcinoma are also met with, if seen in the early stages they are easily removed

**Salivary Fistula** occurs almost solely in connection with the parotid gland It arises from penetrating wounds of the cheek dividing Stenson's duct, or more frequently it follows operations in its neighbourhood It is a very troublesome condition, both for the surgeon who is called upon to treat it, and for the patient who suffers from the inconvenience of saliva flowing down the cheek, the amount being, of course, increased at meal-times Stenson's duct extends forwards from the socia parotidis across the masseter muscle for a distance of about 2 inches, and then turns abruptly inwards to pierce the buccinator, and enter the mouth opposite the second upper molar tooth The buccal and masseteric portions are almost at right angles, the latter being represented by a line drawn from the lobule of the ear to a point midway between the ala nasi and the angle of the mouth The diameter of the duct is about  $\frac{1}{8}$  inch, its narrowest portion being at the orifice

**Treatment**—If the buccal portion is involved, a cure is often attained by slitting up the duct within the mouth, but when the masseteric portion is wounded, and especially if near the socia parotidis, treatment becomes more difficult We have several times found the following plan successful A fine probe is passed along the duct from the mouth as far as the lesion, it is then grasped by forceps inserted through the external aperture, and drawn out on to the cheek, a proceeding sometimes facilitated by slightly enlarging the wound A double thread of silk is now tied to the end of the probe, and drawn through the thickness of the cheek, along the buccal portion of the duct, and out of the external wound A fine drainage-tube is then carried along the same track, and left so as to project both externally and internally A silk thread is attached to each end of the tube, and these are knotted together round the angle of the mouth By this means a passage is re-established into the mouth, and as soon as it becomes easier for the saliva to travel along this than along the external wound, the fistula will close At the end of a few days the outer half of the tube is removed, and only a silk thread allowed to occupy the outer portion of the fistula, which gradually contracts so that more and more of the saliva finds its way into the mouth The silk thread and tube are then finally removed, and if the opening in the mouth is kept patent, the external wound soon heals In those cases where the buccal portion of the duct is completely obliterated or obstructed so that a probe cannot be passed, a trocar and cannula are inserted through the external wound and cheek into the mouth, a silk thread is insinuated through the cannula, and a tube drawn into position, as in the former case The subsequent treatment is the same as that indicated above

## Affections of the Palate

**Cleft Palate**—By cleft palate is meant a congenital defect of the roof of the mouth, whereby the structures entering into its formation do not unite in the middle line, thus allowing an abnormal communication to exist between the nose and mouth. The term does not include losses of substance, resulting from injury, syphilis, or lupus. The cleft usually starts posteriorly, and extends forwards for a variable distance, although it has been known to be limited to the anterior portion of the palate and bony alveolus, but only in exceedingly rare instance. The mildest cases consist merely of a bifid uvula, perhaps not involving the palate at all, the next degree of severity affects the velum alone, more or less of the hard palate

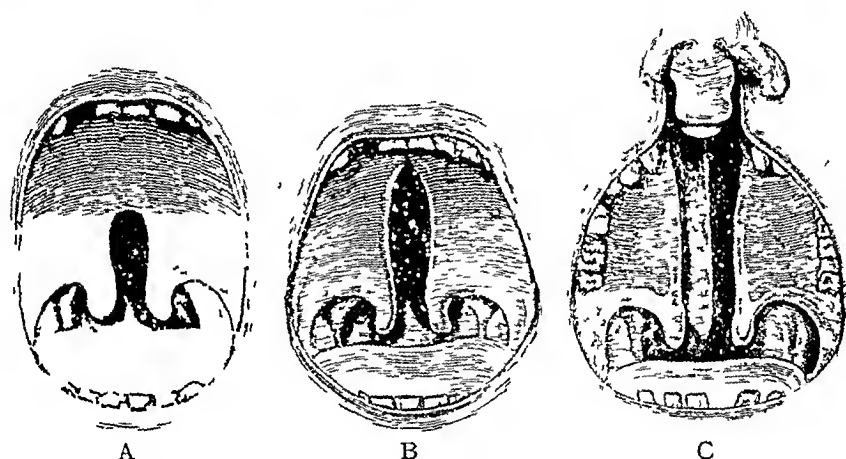


FIG 314—VARIOUS FORMS OF CLEFT PALATE A, INVOLVING MERELY THE VELUM B, TRAVERSING THE HARD PALATE AS FAR FORWARDS AS THE ANTERIOR PALATINE CANAL AND C BEING COMPLICATED WITH A DOUBLE HARE-LIP

may also be implicated, the cleft reaching as far forwards as the site of the anterior palatine canal (Fig 314, B), whilst the severest type of the deformity extends in addition through the alveolus and upper lip on one or both sides, the os incisivum being in the latter case displaced forwards, perhaps on the tip of the nose (Fig 314, C)

On looking carefully at a cleft palate, the defect usually appears to be mesial, but occasionally it seems as if a unilateral or bilateral fissure existed. To understand such an occurrence it must be remembered that three bony processes unite in the middle line of the roof of the mouth, viz., the two palatal processes growing in horizontally from the maxillæ, one on each side, and the ethmo-vomerine septum projecting vertically downwards from the under surface of the fronto-nasal process and base of the skull. All these should amicably join together about the ninth or tenth week of intra-uterine life. If, however, the palatal processes fail to reach the middle line, a median defect appears (Fig 315, A), unless the ethmo-

vomerine septum be so hypertrophied as to project between them, when the appearance of a double cleft is produced (Fig 315, B) When one division of the palate unites with the mesial septum, the other failing to reach it, an apparently unilateral cleft results, most commonly the defect is on the left side, the vomer being attached to the right free edge, a left-sided alveolar hare-lip also complicating the case (Fig 315, C) The reason why the anterior portion of the palate is so rarely affected without the posterior part being also involved is that the union of the various segments progresses from before backwards

The *width* of the cleft and the slope of the segments varies greatly in different cases The wider the cleft, the more unfavourable it is for treatment by operative means, and this is one of the arguments

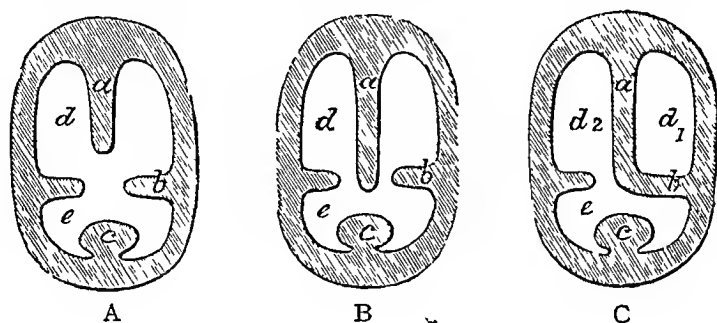


FIG 315 —DIAGRAM TO SHOW THE MODIFICATIONS OF CLEFT PALATE

a, Ethmo-vomerine septum b, palatal segments c, tongue d, cavity of the nose e buccal cavity

used in favour of the removal of the intermaxilla in cases of double hare-lip, so as to allow of the approximation of the two maxillæ Remove it, and they fall naturally together, leave it, and they are wedged permanently apart As to the *slope* of the segments, the more vertical they are, the more favourable for operation, since the flaps of muco-periosteum easily meet in the middle line When the palate is more horizontal, and like a Norman rather than a Gothic arch, the flaps are shorter, and greater lateral displacement is necessary to bring their edges into apposition, this involves much more traction on the stitches, and hence less satisfactory results

The *effect* of such a deformity upon the infant, from a physiological point of view, is very serious The process of *nutrition* is considerably impaired, owing to the fact that the power of suction is lost, and fluids taken into the mouth are apt to escape through the nostrils instead of being swallowed Consequently these children must be carefully spoon fed with the head thrown well back, otherwise they become emaciated and succumb to inanition or intercurrent maladies If they grow up, *articulation* becomes so indistinct that it is often impossible to understand what they say, the voice having a peculiar and characteristic intonation All the letters known as explosives,

whether dentals, labials, or gutturals, requiring a certain amount of air pressure within the mouth for their due pronunciation, are difficult to produce, particularly *b, d, p, t, g, f*, etc. Moreover, the exposure of the nasal mucous membrane to the air is so much greater than usual that it is liable to catarrhal inflammation, resulting in the formation of scabs which undergo putrefactive changes and lead to a sort of *ozæna*. Both taste and smell are much diminished, partly from the unhealthy state of the mucous membrane, and also from the absence of an opposing surface against which the food can be triturated by the tongue. The moral effect of this deformity, particularly when associated with hare-lip, is such as to cause such patients to shun publicity from a nervous feeling of self-consciousness.

As to the best *period* at which to interfere by operation, considerable divergence of opinion exists. Some surgeons advocate its performance at as early a date as possible, and, in fact, it has been undertaken when the child was but a few days old. The success attending such practice has not been gratifying, since infants have no moral control, and are much more likely to suck at the stitches and interfere with them by the tongue, whilst the buccal cavity is small, and the tissues so delicate and friable that the difficulty of the operation is much increased. On the other hand, it should not be deferred too long, bad habits of articulation will be contracted, and subsequent physiological success, as gauged by the quality of the speech, is much less likely to follow. After an extended experience, it may be stated that the operation is best undertaken between the second and the third years, when a child can be easily kept under control. It is most important that the general health be good, and the mouth and throat free from local disease or inflammation. To guard against accidents it is well to make a routine practice of keeping a child under observation indoors for a few days before operating, whilst for choice the spring or summer should be selected. If the tonsils are enlarged, as is not uncommonly the case, it is by no means necessary to remove them if no active inflammation is present, pharyngeal adenoids, moreover, may sometimes be left with advantage, as they subsequently assist in shutting off the nasal cavity during speech.

**Operation** — The child should be placed on a suitable table with a moveable headpiece, if possible, as it is often necessary to alter the position of the head during the proceedings. The arms are fixed to the sides by attaching them to a strap or bandage passed round the thighs below the trochanters, but the patient should not be tied down to the table, so that, although he cannot raise the hands to the mouth during the partial anæsthesia which is often present, yet he can be turned easily to either side so as to allow blood to run from the mouth. Anæsthesia is induced in the ordinary way by chloroform dropped upon the corner of a towel. The greatest care must be taken not to drop chloroform into the mouth, and even Junker's apparatus must be used with care, for fear of the chloroform vapour irritating the edges of the cleft. The mouth is efficiently

gagged open, and preferably by means of a unilateral instrument, which can easily be slipped in or out of position

In a case involving both the soft and hard palate there is no reason why the whole cleft should not be dealt with at one sitting. When the intermaxillary bone has been previously removed, and a considerable gap left anteriorly, it is often only possible to close the posterior two-thirds of the cleft, either dealing with the anterior portion at a later date, or trusting to the application of a suitable obturator, to which artificial incisors can also be attached. The proceeding usually employed is practically identical with that introduced by Langenbeck, and known as *uranoplasty*. For convenience it may be described in four stages

*Stage I Incision and Detachment of Muco-periosteal Flaps*—The knife should be inserted close to the last molar tooth and about half

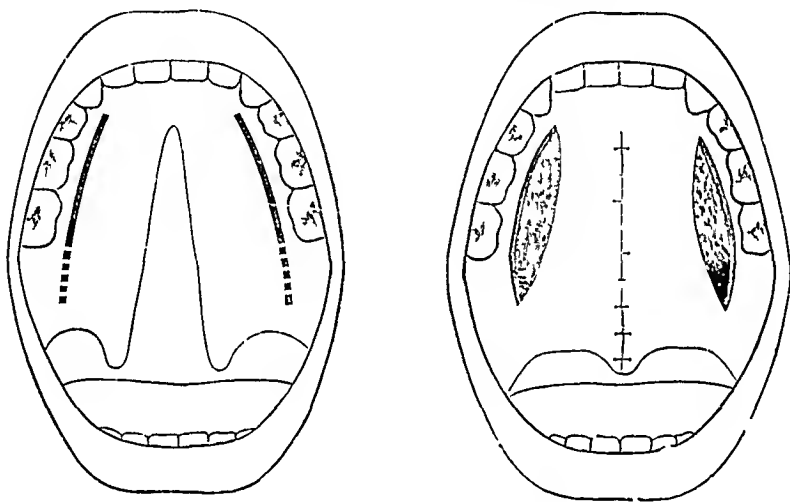


FIG 316 — DIAGRAM TO INDICATE EXTENT OF INCISIONS IN URANOPLASTY

The thick black lines show the primary incision, the thick dotted lines the extension backwards of the same to relieve any lateral tension, the thin dotted lines indicate approximately the position of the free border of the bony palate. The right-hand figure shows the position of the sutures, and the condition of the parts at the close of the operation

an inch from the alveolar margin, and carried forwards parallel to the teeth to a spot just anterior to the apex of the cleft, or, if the alveolus is involved, the incision should stop behind the lateral incisor to preserve the vascular supply of the front of the flap (Fig 316). The muco-periosteum is divided down to the bone, and by the use of a suitable raspatory the soft structures of the palate are stripped up towards the middle line, until the point of the instrument is seen protruding into the cleft. Great care is needed in dealing with the hinder part to ensure its total detachment from the hamular process and back of the bony palate, and yet not to damage it at this, its weakest spot. This must be thoroughly carried out on

either side, the extent of the incisions being shown by the continuous black lines in Fig 316. Copious bleeding always accompanies this stage of the operation, and the head should be turned on one side and lowered, and the pharynx constantly sponged so as to prevent the blood entering the air-passages.

*Stage II Paring the Edges of the Cleft*—This is accomplished by grasping the base of the uvula with a suitable pair of angular catch-forceps. Thus steadied and held, a thin paring can be removed, in one piece, if possible, on the side seized, and the same process repeated on the other. The paring of the edges is purposely deferred until after the muco-periosteal flaps have been detached, because the freshened edges do not thus get bruised by the frequent use of the sponge, moreover, the bevel at which the edges should be pared can be more accurately estimated when the flaps have been loosened.

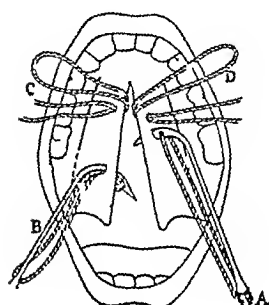


FIG 317

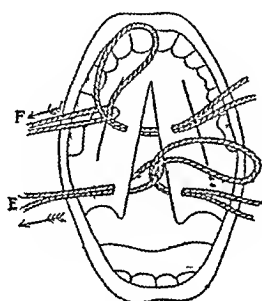


FIG 318

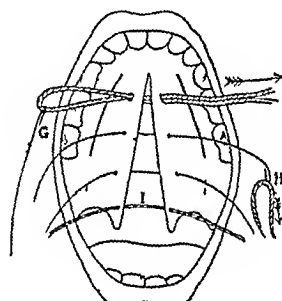


FIG 319

DIAGRAMS TO ILLUSTRATE THE LOOP METHOD OF PASSING STITCHES IN THE OPERATION FOR CLEFT PALATE

The needles and silk thread are, for purposes of illustration, represented much thicker than would be really employed

*Stage III Passage and Tightening of Sutures*—The simplest plan to adopt is that known as the 'loop method' of Sir W Fergusson, and it is carried out as follows. A long handled palate needle with a suitable curve, and threaded with about 18 inches of fine white silk, is passed through the muco-periosteal flap from below upwards, and at a spot about 2 or 3 mm from the margin (Fig 317, A), as a rule, it is not necessary to hold the flap to effect this. The loop of silk projecting from the cleft (Fig 317, B) is now grasped with smooth-nosed forceps and drawn out of the mouth, whilst the needle is withdrawn. A similar loop is inserted through the opposite side of the cleft at an exactly corresponding point, so that there are now two loops emerging from behind through the cleft (Fig 317, C, D). One of these is loosely threaded through the other (Fig 318, E), and the latter gently withdrawn, carrying with it the loop-end of the former (Fig 318, F), and thus a double thread is carried through both sides of the palate, a loop projecting from one side, and the free ends from the other. This process is commenced anteriorly and carried back-

wards until the base of the uvula is reached, the stitches being inserted about half a centimetre apart, so that nine or ten threads may be needed to secure the whole palate. They are left loose, the ends being held by the anæsthetist or assistant against the cheeks until all have been inserted. A 6-inch length of fine well-annealed silver wire is successively hooked over each loop (Fig 319, G), drawn into position by the silk thread (Fig 319, H), and tightened to a suitable degree by a wire-twister, so that the pared edges of the cleft are exactly apposed. This is best undertaken from before backwards. Finally, the uvula is stitched with silk inserted by means of a double-curved needle (Fig 319, I), silver wire would irritate the back of the tongue too much and cause vomiting.

Some surgeons prefer to introduce the wire by means of a specially constructed hollow needle with a double curve, through which the wire is protruded by unwinding a drum in the handle. This is passed through both flaps, commencing at the uvula, and working forwards, tying each stitch as it is inserted.

*Stage IV* —It is now only necessary to take steps for the *relief of all lateral tension*, a most important and essential proceeding. The best way to accomplish this is to prolong backwards through the soft palate the lateral incisions already made so as to thoroughly divide the levator palati (see the thick dotted lines in Fig 316). Occasionally the anterior and posterior pillars of the fauces, containing respectively the palato-glossi and palato-pharyngei muscles, will also need to be snipped across.

The child should now be put to bed with the head low, so that any accumulation of blood or mucus may gravitate easily into the pharynx. The mouth can be washed out with a weak solution of sanitas, although some surgeons prefer not to disturb the parts for three or four days. No nourishment should be given for the first four or five hours, and but very sparingly for the first twenty-four. Milk and water, given by a spoon or from a feeder, will form the staple article of diet. By about the fifth day soft food, such as soaked bread and custard pudding, may be safely given. The patients are generally allowed up on the sixth day. The silver stitches may be left in for ten days or a fortnight without doing any harm.

In dealing with clefts of the soft palate alone, a modification of the above operation may be performed, called *staphylo-raphy*. The edges are first pared, lateral incisions are then made to divide the levatores palati, and the stitches finally passed and tied.

*Results* —It is possible that in most cases articulation will be, if anything, impaired as the immediate result of the operation, since the mechanism which the patient ordinarily employs is thrown out of gear, subsequent education at the hands of a voice-trainer is absolutely essential in order to correct this. Even then the unpleasant articulation occasionally persists, owing to the patient being unable to draw up the velum so as to close the posterior nares, this is due to a reduction of the depth of the soft palate owing to the traction required to close the cleft. In spite of this, however, the operation

is most beneficial in that it shuts off the nose from the mouth, prevents the dropping of mucus, improves the sense of taste, and adds greatly to the general comfort of the patient

**Davies Colley's Operation**—This plan of treatment, introduced by the late Mr Davies Colley, consists in raising flaps of muco-periosteum (Fig 320) in such a manner that whilst one is turned over and attached to the opposite margin of the palate with the mucous membrane upwards, the second flap is laid across it with its raw surface upwards—i.e., in contact with the raw surface of the first flap. Suitable sutures fix the flaps in position (Fig 321). As a rule, two or three subsequent operations are required to complete the closure of the defect. This proceeding has been much utilized by some surgeons, who perform it at a very early age, but we are not convinced as to its superiority over the plan described above.

**Mechanical Treatment** of clefts in the palate by means of obturators or artificial vela is still advocated by some surgeons and dentists in preference to

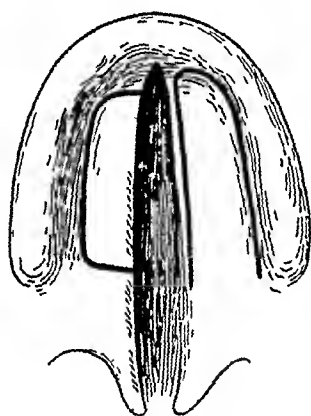


FIG 320—DAVIES COLLEY'S OPERATION FOR CLEFT PALATE

The incisions for the muco-periosteal flaps are here indicated

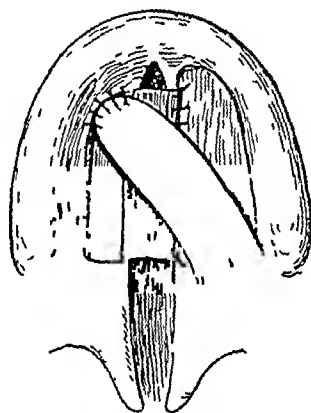


FIG 321—DAVIES COLLEY'S OPERATION COMPLETED

The left hand flap has been turned over, and its free margin stitched to the other side of the palate, whilst the right hand flap has been dissected up and laid across the former with the raw surfaces in contact

any operative interference. An *obturator* consists of an adjustable plate or plug fitted to and closing an aperture in the hard palate. It may be used with advantage in perforations due to traumatism or syphilis, and in apertures left after operations in which portions of the palate are removed, such as excision of the superior maxilla. In cases of double hare lip and cleft palate, where the os incisivum has been extirpated, an aperture is often left anteriorly which cannot be satisfactorily closed except by an obturator, which also serves to carry the necessary artificial incisors, and may have cheek-plates attached to push forwards the upper lip. For whatever purpose an obturator is needed it should never take the form of a closely fitting plug, which, by its constant pressure and irritation, causes the aperture to become enlarged, but always that of a plate, either of thin vulcanite or gold which can be fixed to the teeth, and maintained in position by suction. It is sometimes found, however, that the addition of an



intranasal projection to the upper surface of the plate improves the articulation by diminishing the size of the nasal cavity. An *artificial velum* consists of a plate obturator, to which is attached posteriorly a moveable segment to take the place of the normal velum. Such consists either of a hinged metal plate, resting on the nasal side of the segments of the soft palate, and moved by them, or of a thin indiarubber bag filled with air, sewn to the back of the obturator. They are complicated and difficult to keep in order, and, to our minds, the results of operative interference are superior.

**Ulceration of the Palate** occurs in a variety of forms, *e g*, (a) *simple*, as an accompaniment of general stomatitis. (b) *syphilitic*, which may involve either the hard or soft palate, if superficial, it is usually a late secondary phenomenon, if deep, it involves the bones, and often leads to necrosis, and is then due to tertiary mischief. (c) *lupoid*, a somewhat uncommon condition, which may result in great destruction of tissue, it is usually seen in children, and often associated with a similar disease of the nose, from which, indeed, it may have spread. (d) *tuberculous*, due to the breaking down of a tuberculous abscess under the periosteum, and then complicated with caries of the bony palate. (e) *malignant*, usually resulting from the growth of epithelioma, either starting primarily in the palatal mucous membrane, or extending to it from the tongue, tonsil, or upper jaw.

**Acquired Perforations of the Palate**, though occasionally caused by traumatism or lupus, are in almost all cases due to tertiary syphilis. The ethmo-vomerine septum is often involved in the destructive process, giving rise to a most offensive discharge from the nose. If the soft palate is alone affected, the velum may become fixed by cicatricial adhesions to the back of the pharynx, and pharyngeal stenosis or considerable loss of substance of the velum results. A nasal intonation of the voice is always caused by any condition which interferes with the closure of the naso-pharynx by the velum during articulation. The *treatment* of these conditions should follow the usual antisyphilitic course. Perforations are best remedied by the use of plate obturators. We have seen out-patients make efficient obturators out of a piece of sheet indiarubber maintained *in situ* by suction, or of two pieces stitched together in the middle, one piece passing above and the other below the opening. Occasionally when the aperture is small, the local disease soundly cured, and the general health good, an attempt may be made to close it by stripping up muco-periosteal flaps, paring the edges and suturing them together. The results are, however, seldom satisfactory.

Any of the ordinary forms of inflammation of bone may be met with in the hard palate. **Necrosis** is usually due to tertiary syphilis, or may accompany acute subperiosteal suppuration, extending from an alveolar abscess. In either case the surgeon must wait till the sequestrum is loose, and then it may be removed. **Caries** is generally due to syphilis or tubercle.

The following **tumours** occur on the *hard* palate. Simple *epulis* (p 812) may extend from the alveolus, or an identical condition may start in the middle line. An *adenoma* of the palatal glands is occasionally met with. It presents as a smooth or papillated tumour,

somewhat resembling epithelioma, but distinguished from it by its slower rate of growth, and the absence of ulceration, pain, or glandular enlargement. An operation limited to the soft parts is probably all that is necessary. *Sarcoma* may be primary, and is then often myxo-sarcomatous in type, or secondary. In the former case it simulates rather closely a diffuse alveolar abscess, but is recognised by its slower growth, less pain, absence of inflammation, and, if need be, by the results of an exploratory puncture. *Epithelioma* also occurs, but is uncommon. Treatment for the two latter conditions, if limited to the palate, would consist in partial removal of the affected superior maxilla.

**Elongation of the Uvula** is frequently the result of a chronic relaxed throat. At first it merely lasts for a time, and by the use of astringents disappears, but later on the elongation becomes chronic, and causes great irritation of the back of the tongue and fauces, resulting in a troublesome throat-cough and even vomiting. Under such circumstances it should be removed. After well cocainizing the part, it is grasped by a pair of hook forceps, which seize not only the mucous membrane, but also the muscular structures beneath, and a sufficient amount is then removed by snipping it across near the base with a pair of blunt-pointed scissors, leaving about a third of an inch of the organ behind.

### Affections of the Tonsils

**Acute Tonsillitis** results either from cold or from the inhalation of impure air, especially when contaminated with sewer gas. It is often seen amongst the residents in hospitals (hospital throat), and may precede an attack of acute rheumatism. Three varieties are described.

(a) *Acute superficial tonsillitis*, which consists of a slight superficial inflammation, the result of cold, etc., in which the tonsil participates with the pharynx and velum. There is but little swelling of the part, which, however, becomes red and painful, rendering swallowing difficult. Ordinary anti-catarrhal remedies are necessary, and a chlorate of potash gargle.

(b) *Acute follicular tonsillitis* is characterized by a general enlargement of the organ, which is dusky red in colour and painful, causing obstruction to both breathing and swallowing, the tonsils, perhaps, almost meeting in the middle line. There is a good deal of yellow patchy exudation from the follicles, which may coagulate on the surface and form a false membrane, distinguished from that of diphtheria by its want of adhesion to the subjacent tissue, being readily detached by a camel's-hair pencil. The temperature is high, the glands below the angle of the jaw become enlarged and tender, and may suppurate, the tongue is covered with a thick, whitish fur, and the bowels are confined. Such a condition may herald in an attack of so-called blood-poisoning, or septicæmia.

(c) *Acute parenchymatous tonsillitis*, or quinsy, is a more diffuse inflammation, which is not limited to the organ, but also involves the

soft palate and fauces The swelling is more extensive, the pain is greater, and suppuration frequently results Other symptoms are much the same as in the above

The **Diagnosis** must be made from *scarlet fever* by the absence of the characteristic rash and red tongue of the latter condition, and by the redness being more dusky and less diffuse in tonsillitis From *erysipelas of the fauces*, it is known by the redness being more concentrated, the œdema less marked and more limited, by the glands at the angle of the jaw being less enlarged, and by the absence of any external manifestation of the disease

**Treatment** must always be commenced by a good calomel purge, which may be followed by the administration either of salicylate of soda (20 grains, thrice daily), or of chlorate of potash and sulphate of magnesia, to which a few drops of tincture of aconite may be added if the constitutional symptoms are severe The patient will experience much relief by inhaling the steam from hot water (150° F), in which a little creasote or carbolic acid is dissolved, or the tonsils may be scarified Suppuration is dealt with by a free incision, the knife entering the most prominent part of the swelling, and cutting backwards towards the middle line, the close proximity of the carotid should not, however, be forgotten Hot flannels or fomentations may be applied to the neck and throat, and plenty of fluid nourishment administered This is followed as soon as possible by iron, bark, and other tonics

**Chronic Tonsillitis** appears in two distinct forms

(a) *Chronic inflammatory tonsillitis* occurs in children whose tonsils, after one acute attack, remain enlarged, painful, congested, and very liable to recurrence, which often runs on to suppuration and ulceration After a time the tonsils shrink back and atrophy, becoming hard and fibroid

(b) *Chronic hypertrophic tonsillitis* is met with in tuberculous children, resulting from an overgrowth of the lymphoid tissue, and is usually associated with the presence of adenoids in the naso-pharynx The tonsils are enlarged, pale in colour, and firm in consistence, the orifices of the crypts are very patent, and in them are often seen plugs of mucous secretion, which may become infiltrated with lime salts, forming concretions, which, however, are never of any great size The patients are very liable to recurrent attacks of inflammation, with or without suppuration, and even cysts may form from the blocking of the follicular ducts When much enlarged, the tonsils may meet in the middle line beneath the uvula, causing obstruction both to swallowing and respiration The patient usually breathes with the mouth open, owing to the concurrent naso-pharyngeal obstruction, and from the same cause speaks thickly, as if he had some loose body in the mouth, and necessarily snores during sleep Hearing is often interfered with from the mucous lining of the Eustachian tube becoming thickened and inflamed

The **Treatment** of these cases consists in first attending to constitutional weakness by removal of the patient to fresh or seaside air,

and by the administration of iron and cod-liver oil, at the same time the throat should be painted twice a day with glycerine of tannic acid, or with equal parts of glycerine and tinct ferri perchloridi, or touched with the galvano cautery. Failing this, tonsillotomy should be performed, in children the organ may be cut away as far back as possible, but in patients over the age of twenty only a thin slice should be removed, and never the whole organ, since there is much more risk of grave hæmorrhage, the galvano cautery is much better treatment in adults. It has also been suggested that the voice is weakened by tonsillotomy, but this is somewhat doubtful.

*Tonsillotomy* may be undertaken in two ways

(a) *By the guillotine* The fauces having been carefully and repeatedly brushed with a 5 per cent solution of cocaine, the mouth is opened and one of the many forms of tonsil guillotine introduced, Mackenzie's spade guillotine is as good as any. The ring of the instrument is passed over the projecting organ, external pressure behind the angle of the jaw assisting in this manœuvre. By the pressure of the thumb the projecting mass is cut off by the sharp blade. In dealing with the right side, unless the surgeon is ambidextrous, he had better stand behind the patient's head, looking over into the mouth.

(b) *By the bistoury* The tonsil is seized at its lowest point and drawn well inwards by means of hooked forceps, and the projecting mass removed by a straight blunt pointed bistoury, the base of the blade being guarded, if preferred, by a piece of plaster wrapped round it. The incision should be made from below upwards, and the edge of the knife kept rather in than out, so as to avoid all risk of wounding the internal carotid, which is in close contiguity to the outer surface of the gland. The surgeon must stand behind the patient's head in dealing with the right side, and in front when operating upon the left. Care must be taken to include the lowest portion of the tonsil, which often hangs down into the pharynx, and is liable to be left behind. In children the hypertrophic type of enlarged tonsil may be enucleated without much difficulty by dividing the mucous membrane in front of it, and shelling it out of its bed, the posterior reflection of mucous membrane being subsequently snipped through with bistoury or scissors.

The hæmorrhage, though brisk for the moment, soon ceases if care is taken not to cut too deeply, or encroach upon the surrounding mucous membrane. Should the bleeding continue, it can generally be arrested by douching the face with iced water, or by the local application of wool pledgets soaked in iced boric acid lotion, or in adrenalin, possibly a gargle containing hazeline may be efficacious in bad cases, or the galvano-cautery may be applied. This is more likely to occur in adults than in children.

**Syphilitic Disease of the Tonsil** is met with in various stages. The *primary chancre* is seen occasionally, arising in one case we know of through infection from a stick of caustic which had been previously used to cauterize a syphilitic ulcer and insufficiently cleaned before

being applied to the tonsil, the surface of which was abraded. The glandular enlargement in the neck is very marked in such cases, and the course of the disease usually severe. *Secondary ulcers* of the 'snail-track' type (*plaques muqueuses*) are common in this region, being usually symmetrical. In the tertiary period a *diffuse gummatous infiltration* occurs, involving also the palate and fauces (p 874), and leading to pharyngeal stenosis.

**Tumours of the Tonsil** are almost always malignant in type, but are not very common. *Epithelioma* occurs as a firm indurated infiltration, rapidly spreading to adjacent parts, and involving the lymphatic glands. It generally starts either in the root of the tongue or in the pillars of the fauces, and presents a ragged ulcerated surface with a hard margin and sloughing base. It runs a rapidly fatal course if left to itself. *Lympho-sarcoma* of the tonsil arises in the organ itself, usually after middle life, it presents a smooth, dusky red appearance, the mucous membrane being stretched over it, and feels soft and almost fluctuating. In the early stages it may be freely moveable, but ere long it infiltrates surrounding structures, and affects the neighbouring lymphatic glands. *Round-celled sarcoma* also attacks the tonsil as a primary growth, and is less limited and defined than the former. In all these varieties the growth extends into the pharynx, impeding deglutition and respiration, and ulceration with or without serious hæmorrhage may ensue, indeed, the latter complication is a frequent cause of the fatal result.

**Extirpation of Malignant Tumours** of the tonsil is often impracticable from the extent of the disease and the early implication of the surrounding structures, although it has now been shown that they are more amenable to treatment than was formerly thought to be the case. The disease may be dealt with in two ways. (a) *From the mouth* in the case of the loosely encapsuled and freely moveable lympho-sarcomata. The capsule is divided preferably by a galvano-cautery, and the growth shelled out sometimes with the utmost ease, and with very little hæmorrhage. Recurrence in the lymphatic glands is, however, almost certain to follow. (b) *From the neck*. The best plan is to make an incision along the anterior border of the sterno-mastoid, and carefully dissect down to the pharyngeal wall, removing all lymphatic glands which are enlarged or suspicious, and securing the external carotid or its anterior branches. The mass is then isolated from the surrounding structures and removed. A good many cases have now been reported which were treated in this manner with complete success, even when the tongue, palate, or pharynx were invaded. It is occasionally necessary to make an incision from the angle of the mouth backwards through the cheek, the tonsil is thus well exposed, and can be dealt with satisfactorily. The patient should always be immunized to streptococcal infection before the operation.

### Affections of the Pharynx

**Acute Pharyngitis** is usually associated with a similar inflammatory condition of the velum palati, nasal mucous membrane, and tonsils, and results from exposure to cold, from absorption of sewer gas, and from general diseases of the exanthematous type, *e g*, scarlet fever. It is characterized by redness, pain, and swelling of the mucous membrane, which becomes covered with mucus or muco-pus. An irritable cough, with perhaps sneezing, interference with nasal respiration, and great pain on swallowing, are produced by this condition, and if it spreads to the Eustachian tube temporary deafness is induced. Ulceration of the velum and fauces occasionally follows.

The **Treatment** consists in attending to the general condition, especially if of exanthematous origin, and when due to catarrh, in administering antiphlogistic remedies (*e g*, purgatives, sudorifics, and diuretics) and soothing local applications (*e g*, ice to suck, chlorate of potash gargle, etc). Great relief is often given by inhaling steam from water at 150° F to which a little Friar's balsam has been added.

**Erysipelas of the Fauces and Palate** has been already alluded to (p 117).

**Chronic Pharyngitis** is commonly met with in clergymen and public speakers who are called upon to exert their voices for any length of time, in costers and street-hawkers who shout their wares, and in drinkers and smokers. It may commence as a chronic inflammation, or may follow an acute attack. The mucous membrane is more or less red and infiltrated, with vessels coursing over it, and there is often a good deal of muco-purulent discharge. If the buccal side of the velum palati is affected, there is usually much less secretion than from the pharyngeal aspect, where a considerable amount of dark-green viscid material may collect and cling to the pharyngeal wall, constituting scabs, which may decompose and cause the breath to be somewhat offensive. Two main varieties are described.

1 *Chronic Follicular Pharyngitis*, in which the lymphoid follicles scattered throughout the mucous membrane become enlarged. This is specially evident upon the soft palate, but is often greater in amount upon the upper wall and sides of the pharynx, where there is a mass of lymphoid tissue, sometimes known as the *pharyngeal or Luschka's tonsil* (*vide* Adenoids, p 840). The uvula may be also elongated and hypertrophic in this condition.

2 *Chronic Atrophic Pharyngitis* is usually associated with the atrophic form of rhinitis sicca (p 832), and possibly with chronic laryngitis. The mucous membrane is smooth, dry, and glazed, and the exudation forms adherent scabs. The throat feels dry and irritable, and the voice is often husky.

The **Treatment** of chronic pharyngitis varies with the condition and character of the affection. If of a simple type ('relaxed throat'), all sources of irritation—such as smoking, spirits, and condiments—

must be avoided, the bowels and digestion attended to, and astringent sprays, gargles, or applications made use of, care being taken when necessary to apply these to the naso-pharynx by passing the brush up behind the soft palate. The most useful reagents to employ are the glycerine of tannic acid, equal parts of glycerine and tinct ferri perchloridi, whilst chloride of ammonium inhalations are sometimes valuable, as also sprays of menthol dissolved in paroline. When the inflammation is of the follicular type, it may be further necessary to destroy the follicles with the galvano-cautery after cocaineizing the surface, enlarged and varicose vessels may be divided in the same way. In the dry form of pharyngitis, inhalations of chloride of ammonium are recommended, or chloride of ammonium lozenges, the nasal condition, however, is that which most needs treatment.

**Syphilitic Affections of the Pharynx** may be met with in the secondary or tertiary stages. In the former they are of a superficial character, such as mucous tubercles, snail-track ulcers, etc., in the latter they appear in the shape of a *diffuse gummatous infiltration*, which is often of considerable consequence, both at the time and subsequently. It manifests itself as a widespread nodular thickening of the mucous membrane, especially in the neighbourhood of the fauces and soft palate, which rapidly runs on to ulceration, and may impede both respiration and deglutition. The administration of mercury and iodide of potassium usually causes a rapid improvement, but the subsequent cicatrization may bind down the velum, and lead to pharyngeal stenosis of such a character as to constitute a fibro-cicatricial septum, with an opening through it perhaps only large enough to allow a small bougie to pass. For such a condition much may be done, the opening may be more or less dilated by careful division of some of the bands and the passage of bougies, and the soft palate can be set free from the dorsum of the tongue. Of course, there is a great tendency for the opening to contract again, and treatment by bougies must be persisted in.

A *localized gumma* may form in the submucous tissue, not unfrequently involving the posterior pharyngeal wall, and running its ordinary course with or without ulceration.

**Tumours** of the pharynx are rarely primary. They may extend into it, however, from surrounding parts, *e.g.*, naso-pharyngeal polypi arising from the base of the skull, or retro-pharyngeal growths from the spine.

**Epithelioma** either involves the pharynx primarily, or spreads to it from adjacent parts, such as the tongue or tonsil. The usual type of tumour develops with some amount of ulceration, lymphatic glands become secondarily affected, and the tumour gradually invades surrounding tissues, although it is interesting to note that for some time it is limited to the mucous membrane, extending superficially over it, but not involving the underlying pharyngeal muscles. Death results from hæmorrhage due to ulceration into large vessels, from interference with swallowing or breathing, from pressure on important nerves, or from general dissemination.

**Treatment**—It is only within the last decade that any attempt has been made to deal with these cases, even now the mortality is very high, and statistics go to prove that if the operation involves removal of portions of the upper or lower jaw, a fatal issue is likely to follow. The same precautions as to cleansing the teeth, immunization to streptococcal infection, etc, must be taken, as in dealing with nasopharyngeal or buccal growths. As a general rule, an incision along the anterior border of the sterno-mastoid is the best to employ, although occasionally a second may be required, splitting the cheek towards the angle of the jaw. The external carotid is tied, all glands are removed, and then the growth is extirpated, partly from without, partly from within. It is always advisable to perform a preliminary tracheotomy, and feeding must be undertaken for some days by means of a stomach-tube. Trans-hyoid pharyngotomy is a useful means of approach in some of these cases (p 913).

**Retro-pharyngeal Abscess** is acute or chronic in its course. The *acute* form results from infection through the mucous membrane, as by fishbones, etc, or arises from an inflammation of the lymphatic glands which are found in this situation in children, but atrophy in adults, and derive their lymph from the interior of the nose and nasopharynx. The *chronic* variety generally follows tuberculous caries of the spine, or disease of the bones at the base of the skull. Whether acute or chronic, the abscess forms a tense elastic swelling, situated behind the posterior pharyngeal wall, in the former case it is associated with high fever, and locally much redness and inflammatory œdema, which may even extend to the glottis, and cause dyspnœa, in the latter, where the affection is chronic, there is less local inflammatory reaction, but signs of cervical spinal disease are present. The abscess may burst into the pharynx, or may burrow outwards on either side, being guided by the pre-vertebral fascia, and point either in front of or behind the sterno-mastoid.

**Treatment** should never be delayed, from fear of the supervention of œdema of the glottis. The abscess should be opened from the neck in all cases, as then an aseptic course can be maintained, and there is no fear that the pus will enter the air-passages. If pointing in front of the sterno-mastoid, the abscess is opened in that situation, but otherwise an incision should be made along the posterior border of the muscle, which must be drawn forwards, and the transverse processes of the cervical vertebræ defined. Possibly the abscess will be opened by the necessary manipulation of the wound, if not, the index finger of the left hand should be placed against the abscess wall in the mouth to guard it from injury, and a pair of sinus forceps thrust into it in front of the vertebræ by the right hand. A drain-tube is then inserted, and the case runs an ordinary aseptic course.

### Affections of the Œsophagus

**Malformations** of the œsophagus are congenital or acquired.

A **Congenital** communication may exist between the œsophagus and trachea, either in the form of a small fistula, or the upper end of



the œsophagus ends blindly, whilst the lower end opens into the trachea near its bifurcation. Life is impossible under such conditions, and the children die shortly after birth. Congenital stricture may also be met with near the cardiac orifice, resulting in general distension and dilatation of the œsophagus (*œsophagocœle*). The **Acquired** malformations consist in the development of the so-called *Diverticula*. Two forms have been described by Zenker: (a) *Pressure Diverticula*, which are the more common, and seem to be associated with some congenital weakness of the wall, probably connected with the branchial clefts. They vary much in size, perhaps becoming as large as a child's head, and rarely come under observation before the age of thirty. They usually spring from the posterior wall, close to the junction of the pharynx and œsophagus, constituting sometimes what is known as a 'pharyngocœle', the cavity extends downwards between the œsophagus and vertebral column. The *symptoms* are due to distension of the cavity with food which stagnates and putrefies, forming a swelling in the neck which can be emptied by pressure, the difficulty of obtaining sufficient food gradually leads to emaciation. When a bougie is used, it generally passes into the diverticulum, and hence its onward course is arrested, by careful manipulation it may be kept on the sound wall, and so slipped past the orifice into the stomach. *Treatment*, where possible, consists in exposing the diverticulum in the neck, removing it, and stitching up the opening in the pharyngeal or œsophageal wall. (b) *Traction Diverticula* are much rarer, they usually occur on the anterior wall, near the bifurcation of the trachea, and are due to cicatricial traction from without, as by an inflamed bronchial gland. They are always of small size, often multiple, and cause no symptoms, unless a foreign body lodges in them, when ulceration and perforation may lead to suppurative mediastinitis and death. They cannot be recognised *ante mortem*.

**Foreign Bodies** not unfrequently lodge in the œsophagus, especially in children and lunatics. Portions of food, coins, fishbones, pins, plates of false teeth, etc., are the substances usually met with. The patient complains that something has lodged in the gullet, causing a feeling of pain and distension, whilst swallowing is painful or impossible, and respiration may be more or less hampered. Large bodies are often impacted at the entrance to the gullet, and then cause sudden death from dyspnoea, if the obstruction is not so great and remains unrelieved, œdema of the glottis may supervene. Impaction lower down is likely to be followed by ulceration, perforation, and death, either from hæmorrhage owing to one of the large vessels being opened, or from suppurative cellulitis. In some cases, however (König states about 50 per cent), the foreign body spontaneously passes either into the mouth or stomach.

The **Treatment** varies much according to the nature, size, and situation of the obstructing body. If small and incapable of being detected by a sound—e.g., a fishbone—it is best removed by an expanding probang (Fig. 322), being caught in the loops of thick horsehair forming part of the apparatus. If a coin or small hard

substance is impacted, it may be removed by œsophageal forceps, or by a coin-catcher. If it is impossible to draw it up, it may sometimes be pushed down into the stomach. A large bolus of food may be removed by forceps from the upper part of the œsophagus, and large foreign bodies—*e g*, plates of teeth—may be similarly extracted, though great care must be taken not to tear the mucous membrane. Radiography is now employed to assist in the localization of metallic substances such as coins, as also to determine whether or not they have been dislodged, whilst removal may be much expedited by the use of the radiographic screen.

If impacted in the upper part, *œsophagotomy* may be performed. An incision, 4 inches long, is made along the anterior border of the sterno-mastoid, preferably on the left side, because the œsophagus naturally curves that way. The platysma and deep fascia are divided, and the muscle drawn outwards, the omo-hyoid needs division, and the surgeon then carefully works his way between the carotid sheath on the outer side, and the larynx and trachea on the inner, avoiding the thyroid vessels and nerves. The projection of the foreign body will indicate the situation of the tube, and this is carefully incised and the obstruction dealt with. The œsophageal wound may then be closed by sutures which do not include the mucous membrane, whilst the external wound is either stuffed with gauze plugs or drained. When located in the upper part of the thoracic portion of the œsophagus the tube is opened as low as possible by cutting down on the point of a bougie passed from the mouth, and then it is often possible to extricate it.

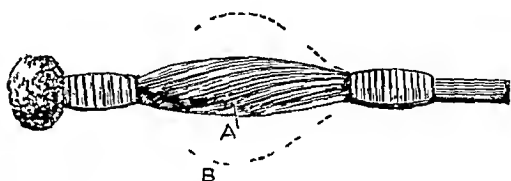


FIG. 322 — EXPANDING PROBANG FOR THE REMOVAL OF FOREIGN BODIES FROM THE ŒSOPHAGUS

When the foreign body is impacted near the cardiac orifice, and cannot be moved either up or down, the stomach may be opened, the fingers or even the hand inserted into it, the cardiac orifice dilated, and the obstruction removed.

When once the foreign body has passed into the stomach, purgatives and emetics should be avoided, and if not of large size and irregular shape, the case is left to Nature, the treatment being merely expectant. The patient is kept quiet, and fed on pultaceous food—such as brown bread, porridge, etc.—and the motions are carefully examined. Should, however, the foreign body be large, and gastric symptoms develop, it should be removed by gastrotomy.

**Inflammation** of the œsophagus, with or without ulceration, is caused by swallowing corrosives or irritants, and, in a more localized form, by the impaction of foreign bodies. The symptoms are pain and difficulty in deglutition, and the treatment consists in the restriction of the diet to liquids, whilst in bad cases rectal feeding may be necessary. Chronic catarrh results from the continual drinking of raw

spirits, and stenosis from cicatricial contraction may gradually follow

**Varix** of the veins in the lower portion of the œsophagus is occasionally met with as the result of pressure on the portal vein, or from cirrhosis of the liver. This is due to the fact that these branches open into the gastric division of the portal system, passing through the œsophageal opening in the diaphragm. Hæmatemesis may result, and has even proved fatal.

**Spasm of the Œsophagus**, or hysterical stricture, arises in neurotic young women, usually under twenty-five years of age, and, although

sometimes independent of organic lesion, is often associated with some slight abrasion or ulceration of the mucous membrane, perhaps originated by the impaction at an earlier date of a fishbone. The symptoms complained of are difficulty in swallowing, and a sensation as of a ball arising in the throat (*globus hystericus*), due to a spasmodic action of the pharyngeal constrictor muscles. At times, when the patient's attention is diverted, deglutition occurs quite normally. The best course of *treatment* is anti-neurotic in character (*e.g.*, cold douches to the spine, massage, the administration of purgatives, valerian, etc.), whilst the passage of a full-sized œsophageal bougie is useful.

**Organic Stricture of the Œsophagus** occurs in two forms—the fibrous and the malignant.

1 *Fibrous Stricture of the Œsophagus* is usually located near its commencement, just behind the cricoid cartilage, and is most frequently caused by the swallowing of corrosives, and the cicatrization of the wounds caused thereby, it

FIG 323 —CANCEROUS GROWTH OF THE ŒSOPHAGUS (TREVES' 'SURGERY')

also results from syphilitic disease. At the cardiac orifice it may arise from the healing and contraction of a gastric ulcer. The main *symptom* produced is a gradually increasing difficulty in the swallowing, firstly of solids, but finally even of fluids. If the obstruction is placed at the upper end of the tube, food is returned immediately, but if lower down, the œsophagus may become dilated, and in this pouch or œsophagocœle the food collects for a time, and then returns unchanged. There is but little pain in this form of stricture, although the patient is usually able to indicate the level of the obstruction.

As the case progresses, he becomes steadily emaciated from sheer starvation, and may even die from this cause

2 *Malignant Stricture of the Œsophagus* is usually epitheliomatous in type, occurring in subjects over forty years of age, and situated either at the junction of the pharynx and Œsophagus, *i.e.*, behind the cricoid-cartilage (Fig 323), or in the middle of the tube, where it is crossed by the left bronchus, or at the cardiac orifice of the stomach, in the latter site, columnar carcinoma is the form usually found. The growth involves the whole circumference of the tube, and sooner or later ulcerates, perhaps perforating the trachea, pleural cavity, or one of the large vessels. Secondary deposits occur in the lymphatic glands, either of the neck or posterior mediastinum, visceral complications being uncommon. The *symptoms* are similar in character to those of fibrous stenosis detailed above, but in addition the vomited materials may contain blood, and there is a good deal of cough and pain, referred usually to the site of the disease. Should the growth be at the upper end of the tube, a tumour may be distinctly felt placed deeply in the neck and more marked on the left side, in the earlier stages nothing can be felt externally, although the side-to-side movements of the larynx may be impeded. Perforation of the trachea leads to the entrance of food into the air-passages, and rapidly results in septic pneumonia and death. When the upper part of the gullet is affected, the growth may spread to the back of the larynx, and cause hoarseness and even aphonia. Occasionally the pneumogastric nerves may be involved in the mass, leading to interference with the action of the heart, whilst implication of the recurrent laryngeal nerve causes constant cough and uni- or bi-lateral paralysis of the larynx.

The **Diagnosis** of Œsophageal stricture must be made on general principles, and by a process of exclusion of the many other forms of dysphagia detailed below. It is confirmed by examining the condition of the tube with an Œsophageal bougie. A conical-ended instrument of medium size should be employed for diagnostic purposes, and by this means the situation of the obstruction can be ascertained. *To pass an Œsophageal bougie* The surgeon stands in front and slightly to the right of the patient, who is seated with the head held forwards—if thrown backwards, the larynx is pressed against the spine, and the difficulty of introducing the instrument increased. The bougie is well warmed and smeared with glycerine, and, having been suitably curved, is guided by the surgeon's left index finger over the epiglottis into the Œsophagus. This stage usually causes a certain amount of discomfort and retching on the part of the patient. Once past the entrance to the larynx, the bougie is pushed steadily onwards, if there is no stricture, the instrument will enter the stomach about 16 inches from the teeth. If any obstruction is present, the large instrument is withdrawn, and the passage of a smaller one attempted. The greatest care must be taken, especially in suspected malignant disease, as it is by no means difficult to perforate the walls and open up the mediastinal tissues, causing thereby a fatal cellulitis. A cancerous stricture sometimes feels rough and is painful, a simple stricture is

smooth, regular, and almost painless. It is by no means easy to distinguish the two forms, and the history of the case and general condition of the patient will need to be thoroughly investigated, a hacking cough with no special pulmonary symptoms is always a bad and suggestive sign.

**Treatment of Fibrous Stricture of the Œsophagus** —(a) *Dilatation* of the stricture by means of gradually increasing bougies, for this purpose it is better to use conical-ended instruments rather than the usual type, which are of the same calibre throughout. An interval of some days should elapse between the attempts at dilatation, and during this period the patient should be given as much food as he can take in the shape of strong broths, minced meat, raw eggs, etc., or, if need be, rectal alimentation must be resorted to. (b) If it is impossible to dilate, or if the stricture recurs, a *Symond's Tube* may be inserted. It consists of a gum-elastic, funnel-shaped tube, passed through the stricture by a whalebone introducer, the funnel resting against the face of the stricture. A thread attached to the upper end is brought out of the mouth in order to remove and clean it, a proceeding needed about once a fortnight. (c) *Internal œsophagotomy* by means of a concealed knife has also been attempted, the stricture being divided posteriorly, it is a somewhat risky proceeding, and is only feasible when the lesion is situated high up in the tube. (d) When the contraction is at the pharyngeal extremity, it may be possible to open the œsophagus below, and either divide and dilate the stenosed portion, or *œsophagostomy* may be performed by sewing the mucous membrane to the skin, thus forming an entrance to the alimentary canal in the neck. Under these circumstances, it is better practice to divide the œsophagus completely, closing the upper end by sutures, and fixing the lower end to the margin of the wound. (e) If the cardiac orifice of the stomach is contracted, the stomach may be opened as in *gastrotomy*, and the fingers used to dilate the stricture (*retrograde dilatation*), a proceeding similar to Loreta's operation for stricture of the pylorus. (f) Where none of these proceedings are possible, or if tried have failed, the stomach may be opened, and division of the stricture by Abbe's *string saw* attempted. The patient is made to swallow one end of a piece of string, or a small shot may be clamped on a piece of fine silk, and allowed to find its way into the stomach. When this viscus is opened, the free end is secured, and by its means a coarse silk thread is carried through the obstruction, by up and-down sawing movements the stricture can be thereby divided, enabling the surgeon to introduce bougies. Excellent results have been reported from such practice. (g) *Gastrostomy* is the final resource, occasionally, when the œsophagus has by this means been kept at rest for some time, the stricture will yield, and dilatation by bougies becomes practicable. In such a case the opening in the stomach may be allowed to close.

**Treatment of Malignant Disease of the Œsophagus** —Dilatation by bougies should not be employed as a routine practice, for fear of increasing the ulceration, causing severe hæmorrhage, or perforating

the walls of the tube. It may, however, be used as a temporary measure in the earlier stages to enable the patient to take an increased amount of food, and thus for a time improve his general condition and render him more fitted to undergo further treatment. Symonds' method of *tubage* may be utilized in malignant disease, the patients often bearing the inserted tube well, even when the cardiac orifice is involved, the lower end then projecting into the cavity of the stomach. Unfortunately these tubes occasionally slip through into the stomach, or the guiding string is swallowed, moreover, under the best circumstances the tube needs changing every fortnight, and the ulceration may be increased thereby. Hence, *gastrostomy*, performed as soon as possible by one of the modern methods, is a much more satisfactory plan of treatment. Excision of the growth in the neck has been successfully accomplished in a few cases when the disease was recognised early, and very limited in extent. Tracheotomy is occasionally required in the later stages, from implication of the glottis or trachea.

By the term *Dysphagia* is meant a condition in which swallowing is painful or difficult. The Causes are very numerous and may be arranged as follows:

i *Pharyngeal*—*e.g.*, acute or chronic inflammation, whether simple, scarlatinal, diphtheritic, etc., ulceration of syphilitic or malignant origin, stenosis, as a result of ulceration, paralysis (*e.g.*, labio-glosso-laryngeal or bulbar) or spasm, impaction of foreign bodies, naso-pharyngeal polypi projecting behind the velum, retro-pharyngeal abscess or tumour, etc.

ii *Laryngeal*—*e.g.*, acute or chronic laryngitis, tuberculous, syphilitic, or malignant disease.

iii *Œsophageal*—*e.g.*, acute or chronic inflammation, impaction of foreign bodies, the presence of diverticula, Œsophagospasm, and simple or malignant stricture.

iv *Extrinsic*. In the *neck*, goitre, enlarged glands, aneurisms, etc., in the *thorax*, mediastinal growths or glands, aneurisms of the aorta and large vessels, tumours growing from the vertebral bodies, pericardial effusion, and displacement backwards of the sternal end of the clavicle.

To investigate a case of *dysphagia*, note (i) the method of onset, whether acute or chronic—if the former, it is probably due to a foreign body, (ii) the condition of the pharynx as seen from the mouth and on digital exploration, (iii) the condition of the neck as seen and felt from without, whether or not a tumour is to be felt behind the cricoid, or whether a goitre or aneurism exists, (iv) the character of the voice, as indicative or not of laryngeal mischief—if the voice is husky, a laryngoscopic examination must be made, (v) the chest must be carefully examined for aneurisms, etc., (vi) the Œsophagus may be auscultated along the vertebral groove whilst the patient drinks water to ascertain the situation of the mischief, (vii) it must be examined finally by bougies. If the obstruction is in the Œsophagus, the patient's age and general condition will give *prima facie* evidence as to whether or not it is due to malignant disease, but it must not be forgotten that the stenosis *per se* causes some of the loss of flesh and of weight. The presence of blood and offensive mucus on the bougie or in the material vomited and the existence of enlarged glands in the neck, will also assist in establishing a diagnosis.

## CHAPTER XXX

### AFFECTIONS OF THE EAR

It is impossible to do more than deal with some of the more important surgical aspects of diseases of the ear in this place, and for a more detailed consideration of the subject we must refer our readers to special text-books.

The **External Ear** is the site of various affections which may come under the observation of the general surgeon. Thus, the pinna may be **congenitally absent**, and even the external meatus closed, a malformation often associated with macrostoma. Nothing can be done for this want of development, and the surgeon must never be tempted to try and dig out the concealed membrana tympani. More frequently **accessory auricles** are present, consisting merely of fibrocartilage covered with fat and skin. **Large and prominent ears** constitute a very unsightly deformity, for which operative interference is occasionally required. The size may be diminished by removing a V-shaped portion from the upper part, the prominence, by excising a portion of skin and cartilage through an incision on the posterior aspect. The wounds thus produced are accurately sutured together, and considerable improvement in the appearance results. **Hæmatoma** of the ear is usually due to injury, but is occasionally idiopathic in origin, especially amongst the insane. The auricle becomes swollen and enlarged, and of a bluish-red colour in traumatic cases (Fig. 324), unless inflamed it should not be interfered with, as a general rule, although, if the appearance of the patient is important, it may be advisable to remove the blood, since its organization and subsequent contraction may lead to considerable deformity. **Eczema**, boils, and other inflammatory affections, are met with in the external ear and pinna, but these call for no special mention.

**Plugs of wax** (cerumen), which become dark and indurated, not unfrequently block the meatus, leading to more or less complete deafness, this may come on suddenly after bathing, owing to the plug rapidly swelling up. If they encroach on the membrana tympani, subjective symptoms of giddiness, vomiting, and rushing noises in the ear may also be caused. On examination with an ear speculum their presence is readily detected. *Treatment* consists in washing them away, after previously softening with oil or glycerine.

A large syringe with a fine nozzle should be used, and a stream of warm water injected along the roof of the meatus, as it returns, the softened masses of wax are washed away. **Foreign bodies** in the meatus, such as buttons or beads, are similarly removed, if possible, by syringing, if this fails, a fine pair of forceps is employed for the purpose, but it must be remembered that behind the foreign body lie delicate structures, which can readily be harmed by the exhibition of impatience or force. Where all other plans fail, the auricle may be turned forwards and the meatus opened from behind. **Exostoses** are occasionally met with springing from the bony walls of the meatus, they give rise to deafness by obstructing the passage, and may be removed by the dental drill.

### Affections of the Middle Ear

**Traumatic Rupture of the Tympanic Membrane** is due to direct or indirect violence. The former cause includes the introduction of foreign bodies, or the ill advised efforts of friends or even of medical practitioners to remove the same. The latter causes rupture of the membrane by the sudden compression of the air in the external meatus—*eg*, by boxing the ear, loud noises as from explosions or big-gun practice, or from diving. The lesion also occurs not uncommonly in fractures of the middle fossa of the skull. The patient complains of pain and deafness, and blood escapes from the meatus, but not to any great extent. On inflating the drum chamber, as by Valsalva's or Politzer's methods, air can be heard to escape through the opening, perhaps with a whistling sound. As a general rule, these cases do well, the wound cicatrizing, and the hearing being fully restored, but the surgeon must at first give a guarded opinion, as there may be some deeper lesion which does not become apparent at first. The greatest care must be taken to sterilize the meatus, although it is not wise to use a syringe for the purpose, by this means infection of the tympanic cavity with pyogenic organisms may be prevented. A strip of gauze is gently inserted into the meatus, and an external dressing applied.

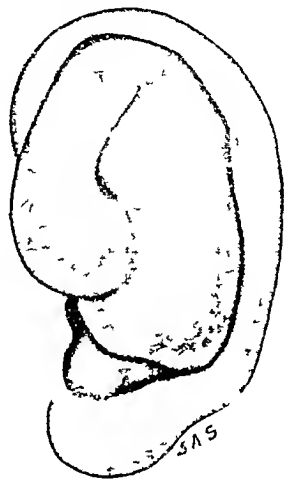


FIG 324—HÆMATOMA AURIS

**Otitis Media**—Inflammation of the middle ear is an exceedingly common affection, and constitutes the great bulk of all ear diseases. It must be remembered that the tympanic cavity is lined by a mucous membrane which is in direct communication through the Eustachian tube with that lining the naso-pharynx, and since this membrane is adherent to the periosteal lining of the cavity, every case of otitis media is likely to be associated with an internal periostitis of the temporal bone.

The *cause* is almost invariably an extension of inflammation along



the Eustachian tube, and the organisms usually present are the pneumococcus or the ordinary pyogenic cocci. The inflammation is similar to that ordinarily affecting mucous membranes, and may be catarrhal or suppurative, acute or chronic. We can here only refer very briefly to that most commonly associated with surgical lesions.

**Acute Inflammation of the Middle Ear** is very common in children, being secondary to lesions of the naso-pharynx, such as an ordinary cold, adenoids, scarlatina, measles, etc. It is ushered in by severe pain in the ear (earache) of a boring, persistent character, together with deafness and perhaps some degree of fever. The pain increases as the secretion accumulates, and if the Eustachian tube becomes closed in consequence of the inflammatory hyperæmia of its lining wall, the tympanic membrane bulges outwards into the meatus and finally ruptures, the pain being at once relieved. The discharge is mucous, or purulent from the first, in the former instance, if infection from the meatus is guarded against, the inflammation may subside, the perforation heal, and no ill result follow. In many instances, however, especially when the child is suffering from measles, or if his resisting powers to microbic invasion are low, pyogenic infection follows, and the catarrhal otitis media is transformed into a suppurative lesion, which may persist as a *chronic otorrhœa* for a lengthy period, and may lead to the most serious, and even fatal, results, from intracranial complications which arise in its sequence.

It is therefore obvious that the greatest care should be taken in the **Treatment** of all cases of acute otitis media. In the first place, the possibility of infection from the external meatus must be guarded against by thoroughly purifying it, the external ear is well washed with soap and water, and the meatus is filled with 1 in 20 carbolic lotion, which is allowed to soak in and act for some minutes. An antiseptic dressing is then placed within and over it. The child is kept in a warm room, and his general condition attended to by suitable diet, diaphoretic medicine, and a smart purge. In mild cases a blister behind the ear will often act beneficially, whilst in more acute ones leeches may be applied. Solution of cocaine or drops of laudanum instilled into the meatus may relieve pain, and in adults it may be possible to cocaine the orifice of the Eustachian tube in the pharynx, thereby relieving the hyperæmia and opening up the tube, and thus giving an exit to the retained discharge. Pain is often relieved by fomenting the ear or by the application of dry heat, as in the form of a hot-water bottle or a baked bran-bag.

When the membrane is seen (by speculum) to be bulging, it is wise to incise it, as a clean cut often heals better than the ragged perforation made by Nature. Local or general anæsthesia is required, and the incision is usually made from just behind and slightly above the handle of the malleus downwards and backwards. An antiseptic dressing is left in and over the meatus until healing has occurred.

**Chronic Otorrhœa**, as already explained, is a common sequence of an acute attack, which may have been purulent from the first, or may have been the result of a pyogenic infection from without of a simple

catarrhal otitis media. The membrane is perforated, and the discharge varies in amount and character. In uncomplicated cases, treatment consists in (1) Improvement of the general health, as by the administration of tonics, residence in fresh country air, and avoidance of chills. (2) The naso-pharyngeal condition must be attended to, so as to ensure a patulous condition of the Eustachian tube, by which discharges may escape. Gargles may be ordered, and adenoids and enlarged tonsils may require removal. (3) The middle ear must be kept free from any accumulation of discharge which might undergo decomposition. When the discharge is abundant, external syringing with boiled water or weak boric acid solution is needed, and the tympanic cavity is inflated from the Eustachian tube by Valsalva's method, Politzer's bag, or even the Eustachian catheter, once or twice a day. If the discharge is slight, the meatus may be packed with boric acid powder, and syringing avoided. Not unfrequently, however, a persistent discharge from the ear is due to some of the complications mentioned below, and further operative treatment may be required.

-The methods of inflating the tympanic cavity mentioned above require a word of explanation.

**Valsalva's Method** consists in closing the lips, holding the nose, and expiring forcibly. the air is thereby driven up the Eustachian tubes if they are patent.

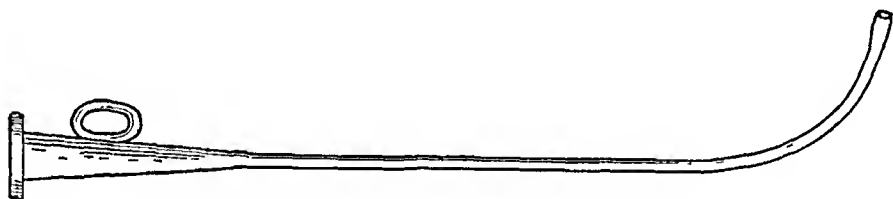


FIG. 325.—EUSTACHIAN CATHETER

In **Politzer's Method** an indiarubber bag with a teat like end is introduced into one nostril so as to occupy it completely. The other nostril is closed by the surgeon's finger. The patient is instructed to take a sip of water and to hold it in the mouth with closed lips until told to swallow. As he swallows, the bag is forcibly compressed, and air is thereby driven up the tubes. An auscultating tube may pass from the patient's meatus to the surgeon's ear, and various sounds, whistling, bubbling etc., may be detected, according to the character of the lesion.

The **Eustachian Catheter** (Fig. 325) can be passed into the Eustachian tube, and the degree of inflation more accurately controlled. The instrument carefully sterilized is passed with the beak downwards along the inferior meatus of the nose until the posterior pharyngeal wall is reached. 'As soon as its tip touches the posterior wall of the naso-pharynx, the *anterior end* of the instrument is slightly raised, and is withdrawn for about half to three-quarters of an inch until the beak is felt to be in contact with the posterior end of the hard palate. The catheter is then rotated through a quarter of a circle until the beak points directly outwards. It is then pushed a little onwards, and is usually felt to slip easily into the opening of the Eustachian tube' (Lambert Lack).

The **Surgical Complications of Chronic Otorrhœa** are frequently serious, and call for prompt treatment, they may be classified under three main headings—the extracranial, the cranial, and the intracranial.

The extracranial complications of otorrhœa are comparatively unimportant

(a) **Eczema** of the meatus is frequently seen, and merely needs the parts to be kept dry and clean, and possibly a little boric acid powder insufflated, it readily disappears when the discharge ceases, but is not unfrequently associated with enlargement of the cervical glands, which may suppurate, or in predisposed individuals may become the seat of tuberculous disease

(b) **Boils** arise from infection of the sebaceous glands in the meatus with pyogenic cocci from the discharge, and are exceedingly painful owing to the denseness of the tissues involved. They should be fomented, and opened when pus has formed

(c) Inflammation may occasionally spread from the meatus to the tympanic plate of the temporal bone, leading to subperiosteal abscess and necrosis, or it may extend into the temporo-maxillary articulation, giving rise to suppurative arthritis and disorganization of that joint (p 824)

The cranial complications of otitis media are often of a grave nature, and may end in permanent deafness, or even endanger the life of the individual

(a) The ossicles frequently necrose, and are cast off in the discharge, and thus hearing may be impaired, although not necessarily destroyed, ankylosis of the ossicles one to another may also be determined, leading to considerable loss of function

(b) The inflammation may extend from the lining membrane of the tympanum to the bony walls surrounding it, giving rise to a limited caries or necrosis of the temporal bone. This may be associated with suppuration within the skull, and any of the intracranial complications mentioned below. The roof of the tympanic cavity (*tegmen tympani*), which is very thin, is especially liable to be affected in this way. If diseased bone can be felt through the external auditory meatus with a probe, an attempt should be made to remove it, if this is impossible the part must be kept clean by the injection of mild antiseptics, retention of discharges being prevented by the regular use of Politzer's bag

(c) **Polypi** may also develop, consisting essentially of granulation tissue protruding through the opening in the membrane, they lead to considerable obstruction, and may do harm by keeping back the discharge. They should be removed by the curette, and the bare bone, usually felt at their base, scraped, the part is subsequently syringed with a weak carbolic solution and dressed antiseptically

(d) **Facial paralysis** not uncommonly arises from sclerosis and thickening of the bony tissue surrounding the aqueductus Fallopi, causing pressure on the nerve in that region. It must be remembered that the bony canal lies immediately behind the tympanic cavity, and to the inner side of the passage from the attic to the mastoid antrum (*aditus ad antrum*). All the muscles on that side of the face are involved, and possibly also the palate and uvula (p 383). No radical treatment is practicable, although the face should be

regularly faradized, so as to maintain as far as possible the tone of the muscles

(e) Inflammation may also extend into the mastoid cells, giving rise to the condition known as *mastoiditis*. The mastoid process is a triangular mass of bone, which is practically undeveloped until the age of puberty. Before that period a single cell relatively of large size communicates with the posterior portion of the tympanic cavity and represents the antrum, it is comparatively superficial, being immediately under cover of the squamous flake of bone, and is in reality petro-squamosal rather than mastoid in origin. After puberty the whole bone becomes hollowed out into a series of spongy cells, lined with mucous membrane, which open into the floor of the antrum. These cells lie below and superficial to the antrum, which is therefore more deeply placed in the adult than in the child. The communication with the tympanic cavity, which in a child is widely open, becomes encroached on and narrowed to a small track in the adult. When the inflammation in otitis media, which has almost always become septic, extends into the antrum, severe local and general symptoms are likely to result. The patient complains of intense pain in the ear, with tenderness on pressure, and perhaps redness and œdema over the mastoid process. The discharge from the ear often ceases for a time at the commencement of these symptoms, but reappears later on. As the case progresses, febrile symptoms of an intermittent type, and even rigors, may supervene, whilst the patient becomes drowsy, or may be irritable and restless. An abscess may form under the periosteum covering the mastoid process, with or without caries or necrosis of the outer table of the bone, in children, where this bony lamella is thin, it is not unfrequently absorbed, and on incising the abscess protuberant masses of granulations, springing from the interior of the bone, may be seen. When an abscess has developed, the auricle is characteristically displaced downwards and outwards. Any of the intracranial complications mentioned below may occur as sequelæ. Occasionally the mastoid trouble is of a more chronic type, and even tuberculous in nature, the cells being choked up with lymph and inflammatory material of a cheesy nature, whilst the bone itself becomes thickened and condensed. The process feels distinctly enlarged, and a good deal of deep-seated pain of an aching character is experienced, and worse at night.

When the discharge is inspissated and mixed with epithelial cells and cholesterine, so as to form flaky masses like the layers of an onion, the condition is known as *cholesteatoma*. It is often the cause of great distension of the antrum, which in a case operated on by one of us measured quite  $1\frac{1}{2}$  inches across. The symptoms, at first of a chronic type, are likely to be followed sooner or later by an acute attack of septic inflammation.

**Treatment** — In the early acute stage belladonna fomentations may be employed, and the patient kept quietly in bed, whilst the diet is regulated and a suitable purgative administered, accumulated dis-

charge is removed from the tympanum by the use of Politzer's bag. Two or three leeches may also be applied over the mastoid process, and relief to the pain thus obtained, though it is often only of a temporary character. It is most important not to rely upon such palliative measures for too long, but when the symptoms are well marked, even in the early stages, and before suppuration has occurred, it is good practice to make an incision (*Wilde's incision*) down to the bone, reaching from the base to the apex of the process, much relief is always obtained by this procedure, and the inflammatory phenomena are sometimes completely checked. As a rule, however, the mastoid antrum *must be laid open* and its contents evacuated (*Schwartz's operation*). Many instruments have been

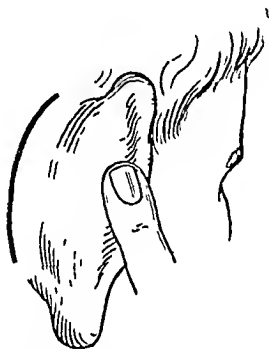


FIG 326 —INCISION FOR  
MASTOID OPERATIONS

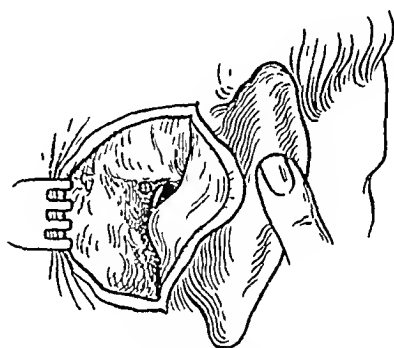


FIG 327 —SITE FOR DRILLING  
BONE IN ORDER TO OPEN  
THE MASTOID ANTRUM

It is often well to apply a chisel over the desired area so as to include a triangle, the centre of which corresponds to the apex of the so called supra meatal triangle. As soon as the outer layers of the bone have been removed by the chisel, the gouge is used to reach the deeper parts.

suggested in order to accomplish this, thus, it has been recommended to use the bradawl, trephine, gouge, or gimlet, the gouge is, however, probably the best, if a burr worked by a surgical engine is not obtainable. A curved incision is made immediately behind the ear, which is drawn well forwards (Fig 326), and the gouge applied on a level with the roof of the external auditory meatus, and about  $\frac{1}{2}$  inch behind its centre (Fig 327). A small dimple in the bone can often be felt at the required spot, which can also be found by taking the point of junction of two lines drawn as tangents to the roof and posterior wall of the bony meatus respectively (Fig 281, C). The direction taken by the gouge should be slightly downwards, forwards, and inwards, and a useful guide will be found in a probe passed down the external auditory meatus, the boring being made exactly parallel to this. In an adult the mastoid antrum is reached about three-fifths of an inch from the surface of the bone. The surgeon recognises that he has opened the cavity by the loss of resistance and the escape of exceedingly offensive pus. The opening is then

freely enlarged by the use of the gouge and cutting-pliers, and the cavity syringed out through the external meatus. Diseased bone in the mastoid process or around the tympanic cavity may be scraped away, and the wound plugged with sterile gauze, it should be syringed through from the external meatus daily. In the more chronic cases it may be advisable to split off the whole of the outer coating of bone from the mastoid process, so as to lay open all the cells, which will often be found filled with inspissated pus.

In the more severe forms it is recommended to detach the auricle posteriorly from the bony margins of the meatus, and then to gouge away the whole of the osseous tissue intervening between the meatus and tympanic cavity in front and the mastoid antrum behind. A

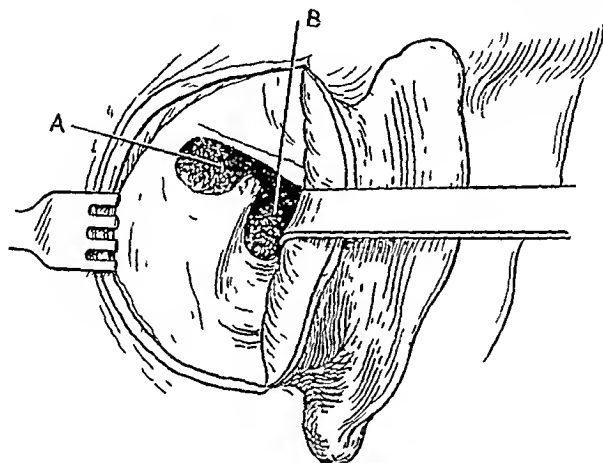


FIG 328 —STACKE'S OPERATION COMPLETED

The antrum (A) has been thoroughly opened up and the bridge of bone covering the aditus removed thus bringing the antrum into free communication with the tympanic cavity (B), which is curetted and the ossicles removed.

metal guide is passed from the opening in the antrum into the attic along the aditus, and all the bone superficial to the guide may be safely removed. The facial nerve and superior semicircular canal lie behind, and are protected by the guide. The remains of the membrane and the ossicles are then removed, and the whole cavity well curetted (Fig 328). The deep portion of the posterior wall of the cartilaginous meatus is incised longitudinally and the margins of the aperture stitched to the posterior edge of the wound, the meatus thus leading to the whole of the opening in the bone, which can in this way be syringed out and cleaned more efficiently (*Stacke's operation*). The results of this proceeding have been very satisfactory, but the proximity of the facial nerve must never be forgotten, and the anæsthetist should be instructed to watch the face continuously for any twitching, which indicates that the nerve is being touched, inasmuch as the surgeon is working at the side, and cannot see.

The intracranial complications of otorrhœa are subcranial abscess,

localized or diffuse meningitis, thrombosis of the lateral sinus, and abscess in the cerebrum or cerebellum

(a) **Subcranial Abscess**—For general phenomena connected with this condition, see p 781. Accumulations of pus occur most commonly along the summit of the petrous portion of the temporal bone, and in the sulcus in which the lateral sinus is lodged. The patient complains of pain and headache, which increase for a time and are then followed by drowsiness, which may pass into coma. The temperature is usually raised, but rigors, even if present at first, are by no means a constant feature of the case. The pulse is of the usual febrile type, viz., quickened, full and bounding. There is no pain in the neck along the course of the jugular vein, but retraction of the head occurs if basal meningitis is present, and vomiting is a marked symptom. Optic neuritis may be observed in consequence of the inflammation extending to the membranes at the base of the brain. There may be some tenderness on pressure over the temporal region, and possibly œdema. In some cases the pus finds its way outwards along the mastoid emissary vein, or through the suture between the occipital and temporal bones.

The **Diagnosis** from *cerebral abscess* is sometimes a matter of considerable difficulty. The symptoms, however, set in somewhat more acutely, whilst the temperature is raised, and the signs of irritation of the membranes, such as retraction of the neck, all suggest that the lesion is extradural, and not cerebral in origin. The pulse is fast, and not slow, and focal symptoms are less likely to develop.

The **Treatment** consists in trephining above and behind the meatus, so as to escape the lateral sinus, and in much the same situation as for a temporo-sphenoidal abscess (*q v*). The pus is washed out, and a drainage-tube inserted for a few days.

(b) **Meningitis** may be localized or diffuse. The former often accompanies some other condition, and is in itself of little moment. It may produce fixed headache, but, if non-suppurative, usually disappears when the originating disease has been cured. The diffuse variety is generally septic in nature, and secondary to some suppurative affection in the neighbourhood, or to thrombosis of the lateral sinus. For symptoms, see p 782. Occasionally a simple serous effusion occurs within the meninges, leading to increased pressure and consequent drowsiness, but disappearing entirely when the cause has been removed.

(c) **Thrombosis of the Lateral Sinus** arises from direct extension of the inflammatory process from the middle ear through the mastoid bone, or it may be set up by a septic thrombosis of the mastoid emissary vein spreading to the sinus. A clot forms within it, which, gradually increasing in size, leads finally to occlusion of its lumen. Infection with pyogenic organisms determines disintegration of the clot, septic emboli are detached, and thus pyæmic symptoms originated. In well-marked cases the thrombus extends as far back as the Torcular Herophili, and downwards along the jugular vein.

The most marked **Symptom** of the case is the sudden appearance

of a high temperature, which is usually remittent, and associated with rigors, vomiting, and localized pain in the head, perhaps most marked over the point of emergence of the emissary vein at the posterior border of the mastoid process. The pulse is slow and easily compressible, and in the later stages the patient is drowsy and dull, probably from serous exudation within the meninges. The discharge from the ear, which may have been previously offensive, usually ceases. Optic neuritis may or may not exist, being often preceded by photophobia. If the thrombus extends into the neck, a firm, tender, elongated swelling is felt in the region of the jugular vein, and, owing to the interference with the venous circulation, the face often becomes dusky. Stiffness of the muscles at the back of the neck is an evidence of a certain amount of associated basal meningitis, as is also the optic neuritis. Suppuration may occur outside the sinus, or around the vein in the neck, which becomes swollen, red, and œdematous.

In well-marked cases the **Diagnosis** is easily made, but in the early stages, and especially in children, it is often a matter of some difficulty. The abrupt onset, the oscillating temperature, the recurrent rigors, the pain in the neck, and the deep tenderness on pressure over the course of the lateral sinus or jugular vein, are the most trustworthy signs of this affection.

**Treatment**, to be successful, should be undertaken early. The skull is trephined at a spot about  $\frac{1}{4}$  inch above Reid's base-line, and about 1 inch behind the centre of the external auditory meatus (Fig 281, A or B). The outer wall of the sinus is thereby exposed, and a puncture with a fine needle readily determines whether it contains fluid blood or thrombus. If it is thrombosed, there is often some evidence of inflammation or pus around it, between the dura mater and the bone. Having thus verified the diagnosis, an incision is made along the anterior border of the sterno-mastoid, through which the jugular vein is tied at a spot below the lowest point of the thrombus, so as to prevent the escape of any more emboli into the general circulation. In old-standing cases this may involve exposing the vein in the lowest part of the neck, and placing the ligature close to the innominate. The lateral sinus is now freely opened, and the septic thrombus partly scraped, partly washed away, additional bone being taken away if necessary. It is desirable, but not essential in the simpler cases, to remove completely the lower part of the thrombus, if such is attempted, the jugular must be opened above the ligature, and the clot syringed or scraped away. Bleeding occurs from the posterior part of the upper opening as soon as all the coagulum is removed, but is easily controlled by plugging the sinus with a small piece of aseptic sponge or gauze. The wound in the neck should be lightly stuffed and not closed, since septic infection and suppuration are almost certain to follow. The upper wound is also packed in the same way, and allowed to granulate.

(d) **Abscess** in the cerebrum or cerebellum, a complication not unfrequently met with, has been already discussed (p 785)



## CHAPTER XXXI.

### SURGERY OF THE NECK

#### Affections of the Neck

**Affections connected with the Branchial Clefts** —In the second or third week of intra-uterine life a series of branchial arches form in the human embryo as in other mammalia, constituting the foundation from which the future structures of the neck are developed. In the majority of mammals five such post oral arches occur, separated from one another by the so called branchial clefts, but in man the fourth and fifth are amalgamated. They project from the side of the primitive spinal column, and consist of mesoblast lined on either side by epithelium. They unite across the median line at an early date, and also one with another, thereby leading to a large extent to the obliteration of the clefts. Occasionally however, this union is imperfect, and sundry malformations result.

It must be remembered that the mandible and the processus gracilis of the malleus arise from the first arch, the Eustachian tube, tympanic cavity, external auditory meatus, and Glaserian fissure from a normally unobliterated portion of the first cleft, the styloid process, stylo hyoid ligament, and lesser cornu of the hyoid bone from the second arch, the body and great cornu of the hyoid bone from the third arch, and the rest of the cervical tissues from the remaining arch, whilst the second, third and fourth clefts are, under ordinary circumstances, totally obliterated.

**Branchial Fistulæ** are due to imperfect closure of the branchial clefts. They consist of narrow sinuous tracts extending inwards from the skin, and perhaps communicating but not necessarily so, with the pharynx. The external opening is usually situated along the anterior border of the sterno mastoid, and most commonly near its lower end, close to the episternal notch, the fistula then arising from the lowest cleft. They are lined with epithelium, and secrete a glairy or mucoid fluid. They are not uncommonly associated with other abnormalities such as macrostoma, absence of the pinna, or accessory auricles situated either near the orifice of the fistula or close to the ear. In the majority of cases they may be disregarded, but if troublesome should be laid open and the lining membrane either dissected away or destroyed with the galvanocautery.

**Branchial Cysts** arise from incomplete closure of a branchial cleft, the unobliterated portion being distended with secretion. They usually appear in adolescents, often between the ages of ten and twenty, and are frequently attributed to a blow which it may be presumed, brings into activity structures which would otherwise have remained passive. They grow slowly and painlessly, forming rounded swellings, often rather soft, with more or less distinct fluctuation, according to the depth at which they are situated. Their contents, if near the cutaneous end of the cleft, are sebaceous in character, similar to, but more fluid than that found in dermoid cysts (viz., flattened epithelial cells, cholesteroline plates and fatty granules). If placed nearer to the pharynx they are occupied by a glairy mucoid fluid. They are usually lined with squamous epithelium, but a few cases have been recorded in which the cells were columnar,

and even ciliated, in character. The most common situation is in the third cleft, the cyst then lying between the thyroid cartilage and the anterior border of the sterno-mastoid, in relation with the great wing of the hyoid bone, when of large size, they may extend beneath that muscle, displacing it outwards. More rarely a cyst arises from the second cleft, being then located in the upper third of the neck, and tending to spread up towards the styloid process, it may even reach from the mastoid process to the hyoid bone, running parallel to the posterior border of the jaw, and fluctuation may be detected through the mouth. *Treatment* consists in extirpation when the condition has attained sufficient size to be troublesome.

**Branchial Carcinoma**—Considerable doubt has been expressed as to whether it is possible for carcinoma to originate in the unobliterated remains of the branchial clefts, cases which might have been considered of this nature being ascribed to developments of epithelioma in the deep lymphatic glands which have undergone cystic degeneration, and secondary to some undiscovered or aborted lesion in the pharynx or larynx. The balance of evidence is, however, in favour of the fact that carcinoma can start in this way, giving rise to what has been described as a *malignant cyst of the neck*. It is characterized by the formation of a tumour placed deeply beneath the sterno mastoid, indefinite in outline, and of firm consistence. Considerable pain is experienced, and lymphatic glands become secondarily enlarged. The disease runs its ordinary course, but may destroy life through hæmorrhage from the main vessels which are invaded by the tumour. The cyst sometimes gives way into the pharynx, and a malignant ulcer of the pharyngeal wall is thus induced. Pathologically, the condition is an interesting one, since the tumour does not always possess the characters of an epithelioma. Its embryonic origin is sometimes indicated by the fact that myxomatous and cartilaginous tissue is included in its substance.\* *Treatment* is usually impracticable owing to the deep connections of the growth.

Various other congenital conditions may be met with in the neck. **Congenital induration of the sterno-mastoid** in all probability arises from injury during parturition, and usually occurs in head presentations, probably from bruising of the side of the neck against the under surface of the symphysis, it is said to be more common on the left side than on the right. In cases that have been examined microscopically, the indurated mass has been found to consist of fibrous tissue. It disappears spontaneously after a time, but may lead to torticollis at a later date. The congenital form of torticollis (p 420) cysts in connection with the thyro-glossal duct, and cystic hygroma, may also be mentioned.

### Cysts of the Neck

1 **Cysts of Congenital Origin**—(a) *Dermoids* occur here as in any other region where congenital remains are found. As already mentioned, they may develop from the branchial clefts, but may also be found in the middle line, or in connection with the thyro-glossal duct. (b) The *thyro-glossal duct* (Fig 329) consists of a tubular outgrowth from the embryonic pharynx passing downwards behind the body of the hyoid bone in front of the larynx and trachea as far as the isthmus of the thyroid gland, which is subsequently developed from it, and unites with the lateral lobes, which in turn spring from the deeper parts of the branchial arches. The upper end of this duct is situated at the foramen cæcum of the tongue, and thence traverses the substance of that organ between the genio-hyo-glossi muscles to reach the hyoid bone, the lower end is represented by the pyramid of the thyroid isthmus. The whole of this tube disappears under

\* For pathological report of a case see Veau, *Revue de Chirurgie*, March, 1900.

ordinary circumstances, if, however, the upper part remains unobliterated, a dermoid cyst may originate from it, placed either in the substance of the tongue or immediately below it (p 855) If the lower portion remains patent, a cyst develops containing mucoid or glairy fluid, which, however, is not present at birth If it bursts spontaneously, or is opened, a so called *median cervical fistula* results, which requires the same treatment as a branchial fistula, viz,



FIG 329 —MEDIAN SECTION OF TONGUE, LARYNX, AND TRACHEA, SHOWING THYRO-GLOSSAL DUCT EXTENDING FROM THE FORAMEN CÆCUM OF THE TONGUE DOWNWARDS BEHIND THE HYOID BONE, AND IN FRONT OF THE TRACHEA TO THE ISTHMUS OF THE THYROID BODY (SEMI DIAGRAMMATIC, FROM COLLEGE OF SURGEONS MUSEUM)

A small dermoid cyst in the centre of the tongue is also represented

incision, and complete removal or destruction of the epithelial lining. Accessory thyroid growths of an adenomatous nature may develop from any part of the duct, but especially from the lower end, they are quite innocent in nature, and unless troublesome may be left alone. (c) *Cystic hygroma* is sometimes congenital, but may also be acquired. It consists of a multilocular swelling, the spaces composing it being due to dilatation of lymphatic spaces, and filled with lymph. The tumour is often of considerable size, with a sinuous, irregular outline, and may produce great deformity and marked pressure effects. The skin over it may be occupied by dilated capillaries or lymphatics. Unless extending to inaccessible parts, such as the superior mediastinum, it should be dealt with by excision (p 358).

2 **Acquired Cysts of the Neck** are of the following types. (a) *Sebaceous cysts* develop in the skin as elsewhere, but need no separate notice. (b) *Bursal cysts* are stated to occur in connection with the larynx and hyoid bone. There is usually a bursa over a prominent prominence

Adam's, and this may become enlarged and distended with fluid. A bursa also exists between the back of the hyoid bone and the thyroid cartilage, which might easily be mistaken for one of thyro-glossal origin. In doubtful cases a microscopical examination of the lining wall will quickly settle the diagnosis, since if it is bursal in origin it is lined with endothelium, whilst if it is thyro-glossal it is lined with epithelium. In the former case incision and drainage usually suffice to bring about a cure, although excision is preferable, in the latter case the lining wall must be entirely removed. (c) *Umbil-*

*locular serous cysts* are sometimes met with in the lower part of the posterior triangle, constituting the condition known as 'hydrocele of the neck'. They contain serous fluid, with perhaps an admixture of blood. Their origin has not been defined with any certainty, but they are probably due to a dilatation of the lymph spaces, and are best treated by excision. (d) *True hydatid cysts* also occur in this region (p. 220). (e) *Blood cysts* have been found in close connection with the large vessels of the neck. They are possibly due to the dilatation of a vein, and may communicate or not with some vascular channel, such as the jugular, being then partly emptied on pressure. Where no communication with a venous trunk exists, the lining membrane is intensely vascular. In the former case they may be treated by excision, securing the vessels with which they communicate above and below, in the latter tapping and injection of perchloride of iron may suffice, or they may be opened and stuffed. (f) Cysts are also occasionally met with in connection with the *salivary* glands and the *thyroid* body. (g) *Malignant cysts* arise, as already mentioned, from the remains of the branchial clefts, or from a degeneration of epitheliomatous lymphatic glands. They are often of large size, and their removal is impracticable owing to the adhesions which they contract to the deeper structures.

### Cut Throat

Injuries of the neck are commonly met with in cases of attempted homicide or suicide, and vary much in severity according to the extent and position of the wound. A right-handed suicide usually cuts his throat from left to right, and therefore the incision is bold and clean on the left side, tailing off towards the right, in a left-handed suicide the incision runs in the opposite direction. A homicidal cut throat varies in its direction according to whether it is done from behind or in front, and also with the hand employed. If the front of the neck is mainly involved, the air-passages are laid open, and the patient's life, though much endangered, is not necessarily destroyed. If, however, the wound chiefly affects the side, the great vessels and nerves may be divided, and death from hæmorrhage is very liable to ensue. The course and treatment of the latter class of case require no particular notice, since the general principles relating to all wounds must be adhered to. Where, however, the air-passages have been opened, special complications arise, requiring suitably modified treatment.

**Wounds involving the Air-passages**, the result of cut throat, may be situated at four different levels: (a) above the hyoid bone, encroaching on the base of the tongue, (b) through the thyro-hyoid space, the most common situation, (c) in the larynx, and (d) opening or dividing the trachea.

The **immediate effects** of such lesions are due to shock, hæmorrhage, asphyxia, or the entrance of air into veins. When above the *hyoid bone*, the root of the tongue and submaxillary region are involved,

and hæmorrhage from the lingual or facial arteries or their branches follows, if the wound extends far enough, the main vessels are divided, and death results. In the less severe cases the patient runs considerable risk of being suffocated by the epiglottis and base of the tongue falling back over the larynx. Much difficulty will be subsequently experienced in feeding the patient, owing to impairment of the movements of the tongue. When the *thyro-hyoid* space is opened, the origins of the facial and lingual arteries are again in danger, as also the upper part of the superior thyroid. The base of the epiglottis is divided, and portions of mucous membrane around the entrance of the larynx may be detached, and cause obstruction to respiration. Blood may also trickle down the larynx into the trachea, and lead to asphyxia. Wounds of the *larynx* are usually transverse, and not very extensive, owing to the resistance offered to the knife by the cartilage. The thyroid body may be wounded and bleed freely, otherwise there is but little hæmorrhage. Blood may find its way into the trachea or lungs, and asphyxiate the patient. When the *trachea* is involved, the common carotid and inferior thyroid vessels are very liable to be wounded, giving rise to severe, if not fatal, hæmorrhage. Asphyxia may be brought about by displacement of the severed portions of the tube, or from the entrance of blood into the air-passages, whilst air may also be sucked into opened veins. The recurrent laryngeal nerve may be divided, causing paralysis of the larynx.

The **secondary effects** following cut throat are mainly inflammatory in origin. (a) Any form of *septic inflammation* may occur in the wound, possibly giving rise to cellulitis, which may spread downwards to the mediastinum. Where it involves the tissues above the entrance to the larynx, œdema of the glottis may be produced. Secondary hæmorrhage also arises from this cause, and even general pyæmia. (b) *Inflammation of the air-passages*, tracheitis, bronchitis, or broncho-pneumonia, frequently follows, partly as a result of the entrance of cold air, partly from the admission of septic material, such as food, decomposing blood-clot or discharges. The patient may become cyanosed from these causes, and in consequence of this partial asphyxia, the sensibility of the mucous membrane of the glottis is diminished, allowing of the passage into it of food which appears at the mouth of the wound, in some cases this may have arisen from division of the superior laryngeal nerve, but the depth at which this structure is situated in the neck makes it difficult to conceive how it could be divided without injury to the main vessels. (c) *Surgical emphysema*, or the entrance of the atmospheric air into the cellular tissue, may also follow a wound of the air-passages. It is not limited to the neck, but extends to the trunk, being recognised by the puffy distension of the part, and by a soft crackling crepitus elicited on pressure. It is of no great consequence, and usually disappears in a few days. (d) *Septic traumatic fever* is almost always present in these cases, the temperature varying with the extent of the inflammation in the cellular tissue or in the lungs.

The **Treatment** consists in securing all bleeding-points, if possible, but occasionally they are placed so deeply that it is necessary to tie the external carotid. General oozing from the surface must be attended to, for fear of blood being sucked into the air-passages, if it persists after thoroughly opening the wound and exposing it to the cold air, it must be checked by sponge pressure. Every attempt should be made to render the wound aseptic, and if there is a reasonable prospect that this has been attained, it may be closed by sutures in the ordinary way. Where, however, asepsis is doubtful, only the ends of the incision should be drawn together, the central portion being left open.

The treatment of the air-passages varies with the site of the lesion. If the trachea has been roughly divided, the portions should be steadied by a stitch on either side, and a tracheotomy-tube inserted—at any rate, for a few days, in some cases where cleanly cut, total closure without the use of a tube can be safely effected. When the wound involves the larynx, it is desirable to close the opening at once, since the larynx does not readily tolerate the presence of a tube, if it is necessary to introduce one, it is better to perform a high tracheotomy. When the wound involves the thyro-hyoid space, or is situated above the hyoid bone, it is quite safe in many cases to close the wound layer by layer after carefully disinfecting it. The mucous membrane is first dealt with by stitches which do not penetrate its whole thickness, and then a more thorough purification of the wound can be undertaken, if the epiglottis is divided, it must be accurately sutured. If there is any doubt as to the advisability of this proceeding, a high tracheotomy is first performed, and then the wound closed as far as possible.

In every instance the head should be flexed on the chest, and in suicidal cases a careful watch maintained to prevent the patient tearing the wound open. Extreme shock from loss of blood is dealt with by the infusion of saline solution, and the patient's general health attended to. Feeding should always be undertaken through a tube passed into the œsophagus, whether that structure is wounded or not, and such should be continued until the patient's natural powers of swallowing are restored.

The following **Sequelæ** occasionally result from a cut throat.

(a) An *aerial fistula* is a persistent abnormal communication between the air-passages and the external air, and occurs most often in the thyro-hyoid space, the skin and mucous membrane being continuous one with the other around the margins of the opening. In some cases it may be closed, but if laryngeal stenosis or adhesions are present, it must be left alone for a time until these conditions have been treated. The operation consists in separating the skin from the mucous membrane, and in order to accomplish this, the external wound must be enlarged vertically. The edges of the mucous membrane are then pared, and stitched together horizontally. The external wound is either left open to allow of the escape of air and discharge, or may be partially closed, and a drainage-tube or gauze stuffing

inserted (b) *Laryngeal or tracheal stenosis*, due to the cicatrization of wounds in these regions, may be remedied by wearing an O'Dwyer's tube (p 922) for a time, or may necessitate the constant use of a tracheotomy-tube (c) *Aphoma* may arise from division of the recurrent laryngeal nerve, and is then usually persistent (d) *Œsophageal or pharyngeal fistulæ* may also in rare instances complicate the healing of an extensive wound in the throat, but tend to close of themselves, and require no special treatment

### Diseases of the Thyroid Body

**Goitre** — Enlargement of the thyroid body, or, as it is termed, bronchocèle or goitre, is a condition frequently seen in this country, and to which much attention has been directed of recent years, owing to the discovery that the thyroid body exercises considerable influence over the metabolism and nutrition of the body. Total absence or removal of the gland or its complete degeneration leads to accumulation of mucin in the body, producing myxœdema or tetany, whilst recently it has been suggested that the symptoms of Graves' disease are due to the excessive absorption of normal or vitiated thyroid secretion.

The Causes of bronchocèle are still enshrouded in a good deal of uncertainty. It occurs endemically in this and some other countries, being especially frequent in the hilly parts of Derbyshire and Gloucestershire (and known, in fact, as Derbyshire neck), it is also exceedingly common in Switzerland. The old idea that it occurs more frequently in places located on chalk or magnesian limestone is not true, it being more common, perhaps, in regions where the green sandstone and carboniferous limestone crop up. Possibly the disease is due to the presence or absence of some mineral constituent of the drinking-water, and the discovery made by Baumann, of Friburg, suggests that an absence of iodine is the cause of the trouble. At any rate, iodine is to be found in the normal thyroid secretion in close combination with albumen, whilst it is absent in cases of goitre, the enlargement of the gland being looked on in the light of a compensatory hyperplasia. Other causes which have been suggested are want of sunshine and air, as in the case of individuals who live in valleys into which the air does not readily penetrate, or in the underground kitchens and cellars of large towns, defective sanitary conditions and the habit of carrying weights upon the head also possibly assisting. In the form ordinarily met with, it is not hereditary to any great extent, and is not influenced by intermarriage, but it may be congenital, and if associated with skeletal changes, defective growth, and intellectual weakness, constituting the condition known as cretinism, and in reality a manifestation of myxœdema, it certainly runs in families. Cretinism is, however, more frequently due to total absence of the gland than to degeneration of a goitrous tumour. The ordinary type of goitre seen in this country is much more common in women than in men.

\* For fuller information than can be given here, see Berry, 'Diseases of the Thyroid Gland and their Surgical Treatment' J and A Churchill 1901

**Varieties and Clinical Features**—Four chief forms of goitre are described, viz The parenchymatous or simple, the cystic, the fibro-adenomatous, and the exophthalmic, but the thyroid body may become enlarged in other ways, giving rise to the conditions known as malignant goitre and acute goitre, whilst acute inflammation is sometimes seen

**General Features**—In all these cases the thyroid body is the site of a swelling involving its whole substance, or one or other of its lobes, or possibly the isthmus alone Its consistence varies with the nature of the growth, but it always moves with the larynx on deglutition In every form there is probably a certain amount of



FIG 330—FRONT AND LATERAL VIEW OF A PARENCHYMATOUS GOITRE

The right lobe had been removed by a former operation

anæmia, whilst some of the symptoms characteristic of the exophthalmic variety are often produced even in simple cases, possibly from the excessive absorption of thyroid secretion Pressure on surrounding structures leads to dyspnoea or dysphagia, and cerebral symptoms may arise from interference with the main vessels, which are displaced outwards The trachea is especially liable to changes of situation and shape from its compression, it is usually flattened from side to side (*scabbard trachea*), and is sometimes pushed an inch or more from the middle line, atrophy of the cartilaginous rings may also be induced If, as sometimes happens, the goitre develops downwards, pushing behind the sternum (*intrathoracic goitre*), the trachea is likely to be compressed from before backwards, and respiration may then be accompanied by stridor, but with no aphonia Pressure



on the recurrent laryngeal nerve leads to harshness in speaking or aphonia, and to spasmodic attacks of dyspnoea, which may even prove fatal. It must be clearly understood, however, that the effects produced by a goitre are not necessarily proportionate to its size, some of the smaller growths at times produce severe symptoms.

**Simple or Parenchymatous Goitre** (Fig 330) consists of a diffuse overgrowth of the whole thyroid body, the parts retaining to a great extent their usual proportions. The enlargement is due partly to an overgrowth of the glandular tissue, but also to an accumulation of colloid material within the vesicles, a normal amount of fibrous stroma is usually present. The whole gland is generally involved, but possibly one lobe is larger than the other. It is soft and elastic



FIG 331—FIBRO-ADENOMA OF ISTHMUS OF THYROID BODY IN A WOMAN, AGED TWENTY-THREE YEARS

to the touch, quite painless, and there may be some amount of lobulation. Not uncommonly it is associated with a cystic development or new formation of an adenomatous type, and malignant disease is always preceded by this condition. When the interstitial tissue is abnormally abundant, as often occurs in the later stages, the tumour feels harder than usual, and is more definitely lobulated. It is then termed a *fibrous goitre*, and if the sclerosis is very marked, myxoedema may supervene.

The **Fibro-adenomatous Goitre** (Fig 331) consists in the development of one or more encapsulated adenomatous nodules in the substance of the thyroid body, which is itself concurrently enlarged. These nodules are perhaps most common in the isthmus, but may occupy one or other lobe, or, when multiple, be scattered through the substance of the organ. If situated near the surface, their limitation and free mobility in the gland can be easily detected, but when placed

deeply their special features cannot be recognised. Two varieties have been described. (a) The foetal, in which the growth is solid and homogeneous, consisting of closely apposed alveoli in which there is no colloid development, and identical in structure with embryonic thyroid tissue. Such growths are usually seen in young people, they are seldom very large, but frequently rather vascular. (b) The more ordinary type of adenoma resembles ordinary adult thyroid tissue more closely, and shows a considerable tendency to cyst formation. It is impossible to draw an exact line of separation between this latter condition and the simple hypertrophy, which is often of a diffuse adenomatous nature.



FIG. 332.—DIFFUSE FIBRO-ADENOMATOUS GOITRE (KING'S COLLEGE HOSPITAL MUSEUM)

**Cystic Goitre (Cysto-adenoma)** arises from the dilatation into cysts of alveolar spaces in the normal gland tissue or in a localized adenoma, the interalveolar walls being absorbed. They may be single or multiple, and contain either a thin fluid or a thick grumous colloid material, somewhat like furniture polish. Intracystic growths of a papillary nature are not unfrequent. The lining membrane of these cysts is epithelial in nature, the individual cells being cuboidal when the cyst is small, and flattened out or squamous when large. It is sometimes intensely vascular, and hæmorrhage into the cysts is by no means uncommon, causing the contents to be brown or blood-stained.

Secondary changes occur in any of these varieties, chiefly affecting

the interstitial tissue, which may develop into cartilage or bone, or may calcify, but only in very chronic cases. Hæmorrhage into the alveolar spaces or cysts is not uncommon, acute infective inflammation may also involve the mass, and malignant disease, usually of a cancerous nature, sometimes supervenes.

As a rare complication may be mentioned general dissemination, giving rise to secondary growths, which are usually found in the short and flat bones, especially the cranium and vertebræ, but occasionally in the viscera. Their texture is usually identical with normal thyroid tissue, but may be more cellular and of a cancerous type, and may be sufficiently vascular to pulsate. They produce local symptoms of varying gravity. The thyroid body may be apparently normal or the site of a simple goitre.

The **Treatment** of the three preceding forms of goitre may be considered together, as they are very different in nature to those which follow. In the early stages palliative measures can be employed, consisting in the improvement of the general health and the correction of errors in the personal and sanitary hygiene. Change of air to the seaside is often advisable, whilst iron and iodide of potassium may be administered internally, and iodine paint or iodide of potassium ointment applied locally. In India cures are often produced by inunction of iodide of mercury ointment, the part being subsequently exposed to the rays of the mid-day sun, such treatment is generally impracticable in this country. The deficient amount of iodide present in the gland in these cases explains why this drug is so pre-eminently useful, and it has been found that the active principle of the gland isolated by Baumann and called 'thyro iodine' is the best form in which it can be administered. The exhibition of thyroid extract is sometimes followed by a diminution of a simple goitre, and the same explanation of its value probably holds good.

In cases where, in spite of such treatment, the growth persists or increases in size, other measures must necessarily be employed, and there is no doubt that removal of the tumour or of a part of the gland is the best practice to adopt. Total extirpation, as already mentioned, results in myxœdema, but as long as a sufficient portion of the secreting substance is left, whether it is derived from the isthmus or from one of the lobes, no such accident need be feared. The operation necessitates a somewhat deep dissection, and will encroach on important structures, but with due care and the maintenance of efficient asepsis, the most satisfactory results are obtained, except when the growth is of very great dimensions. We would particularly emphasize the fact that goitres should be treated in the same way as other new growths, viz, by removal when small. There is still, unfortunately, a considerable tendency amongst practitioners and patients to leave them untouched until they are of large size, thus greatly increasing the risk of the operation. Other plans of treatment have been utilized in the past, e.g., ligature of the thyroid vessels, division of the isthmus, curetting the mass with a large

\* Patel 'Tumeurs benignes du corps thyroïde donnant des metastases,' *Rev de Chirurgie* 1904

Volkman's spoon, passage of a seton, or intraglandular injection of irritants, such as tincture of iodine, but they should be entirely discarded in favour of more radical measures

*Partial thyroidectomy* (or Kocher's operation) is conducted as follows. An incision is made over the most prominent part of the tumour, preferably along the lower third of the anterior border of the sternomastoid. Kocher recommends a transverse or angular incision in order that the scar may be less visible, and this may be employed in suitable cases. The platysma and deep fascia are divided, the sternomastoid drawn outwards, and the sterno-hyoid, sterno-thyroid, and omo-hyoid displaced inwards, or, if need be, divided. The lobe to be removed is thus exposed within its capsule, which should not be opened. The limits of the mass are defined by the finger or a blunt dissector, and the vessels entering or leaving it are secured. The superior thyroid vessels are doubly ligatured and divided at the upper end of the growth, the middle thyroid vein is secured at the middle of its outer border, whilst the inferior thyroid vessels are dealt with below, special care being taken of the inferior or recurrent laryngeal nerve by tying the vessels as near to the gland as possible. The lobe is now freed from the underlying structures, as also the isthmus from the trachea. In detaching the latter, the surgeon must not forget that the cartilaginous rings may have been absorbed, and that the walls of the trachea, being then merely fibrous in nature, are easily wounded. The isthmus should be transfixed and tied in two halves with a silk ligature, so as to prevent hæmorrhage. The growth can now be removed, the bleeding-points secured, and the wound closed, the muscles and fascia being drawn together by buried stitches. A drainage-tube is best inserted for twenty four or forty-eight hours, as it is difficult to employ much pressure on the neck, but this precaution may sometimes be omitted. Healing by first intention should be the invariable result.

*Fibro-adenomata*, when multiple or deeply placed, are treated by extirpation of the affected lobe, but if the new growth is single and superficial, its enucleation should be undertaken by the proceeding known as *Socin's operation*, which has been mainly popularized in this country by Mr C. J. Symonds, of Guy's Hospital. The skin and muscles are divided as before, and the gland substance and capsule incised down to the growth, which is readily shelled out.

A single *cyst* is treated in the same way as a fibro-adenoma, viz, by enucleation, if several cysts are present, removal of the affected lobe may be necessary. The old line of practice, which is still occasionally utilized, consisted in tapping with a full-sized trocar and cannula, and injecting with tr. ferri perchlor. or iodine. Good results sometimes followed these measures, but occasionally the sudden relief of tension within the cyst gave rise to severe hæmorrhage from its walls, which threatened the patient's life. In such cases the cyst was laid freely open, and the cavity plugged with sponges or gauze soaked in some strong hæmostatic, or it was sometimes feasible to rapidly enucleate the whole cyst, and then command the hæmorrhage by ligaturing the supplying vessels.

*Myxœdema* (or *cachexia strumipriva*) is a curious condition, which, as already mentioned, supervenes when the thyroid body is totally removed, or so absolutely disorganized or infiltrated by a new growth as to be functionless. Although it is possible that we still have much to learn of the duties of this organ, yet we do know that the elimination, if not the development, of mucin in the body is controlled by it, and that its absence leads to an accumulation of this substance in the blood and tissues. The condition and appearance of the individual are very characteristic. The face is puffy, waxy white, and expressionless with perhaps a hectic flush over the malar eminences, the tongue is enlarged, the limbs become thickened and clumsy by an increase in bulk of the soft tissues; there is often a puffy mass occupying the supra-clavicular fossa, which, however, does not pit on pressure. The mental faculties are dulled, and all intellectual processes are slow; the temperature is subnormal, and the heart's action weakened. Left to itself, death will supervene from *asthenia* sooner or later, should the case be treated by thyroid gland or extract (half a gland, raw or lightly cooked twice a week, or a 5-grain tabloid once or twice a day), the symptoms soon disappear, and the change from the dull, heavy condition of *myxœdema* to one of normal health of mind and body is almost miraculous.

Similar treatment should be employed for *myxœdematous cretins*, who often start growing rapidly as soon as treatment commences.

*Tetany* is another condition which sometimes obtains after complete removal or disorganization of the thyroid body.

**Exophthalmic Goitre**, or, as it is often termed, *Graves' or Basedow's disease*, is a condition characterized by a diffuse enlargement of the thyroid body, which often pulsates forcibly owing to the dilatation of the vessels (particularly those in the capsule), associated with marked *anæmia*, severe palpitation and cardiac irritability (*tachycardia*), and protrusion of the eyeball (*exophthalmos* or *proptosis*). The nature of the disease has long been a topic of discussion, one of the earliest ideas being that it results from some derangement of the sympathetic nervous system, or possibly of the medulla. Lately, however, owing to the fact that in cases where thyroid extract has been given to excess symptoms somewhat akin to those seen in this condition have arisen, it has been suggested that the disease is due to the excessive absorption of thyroid secretion, although why it occurs in some cases of enlargement, and not in others, has not been explained. In all probability the truth lies half-way between the two theories, the enlarged thyroid and some of the symptoms being alike due to some central disturbance in the upper part of the medulla, whilst others are due to excessive absorption of thyroid secretion.

The patients usually affected are females, about the middle period of life, whose menstrual functions are often impaired. Overwork, worry, and severe mental strain, are apparently responsible for the onset of the symptoms in many instances, and a sudden shock or fright accounts for others. The protrusion of the eyeball is a marked feature of the case, and is sometimes due to an increase of the orbital fat. Contraction of the so-called muscle of Muller (unstriated muscular fibres stretched across the sphenomaxillary fissure) has also been suggested as a more plausible theory. When the patient looks down, the upper eyelid does not immediately follow the eyeball, allowing the white sclerotic to be seen between the lid and the cornea (*von Graefe's sign*). A fine fibrillary tremor of the limbs is also commonly observed in these cases. The patient is always extremely

nervous, and the pulse-rate high, any exertion or excitement increases the irritability of the heart's action, and may induce considerable respiratory distress. Left to itself, the disease in some cases tends to improve, but in others it may progress to a fatal issue from asthenia or cardiac complications.

**Treatment** consists in freeing the patient, if possible, from all sources of worry, whilst bromides, iron, and perhaps iodide of potassium, are administered internally, attention being also directed to correcting menstrual derangements, or any other abnormalities of function or structure, thus, the cure of a nasal catarrh by cauterizing the nasal mucosa has several times led to a rapid amelioration of the symptoms. Phosphate of soda has lately been much commended in this disease, and Kocher speaks favourably of it when conjoined with suitable hygienic measures. Thymus extract has also proved beneficial.

Since the introduction of the theory that the derangement is mainly thyroidal in origin, surgical treatment by removal of a portion of the gland has been suggested, and the results gained so far have been encouraging, although the proceeding is not devoid of serious risk, and should not be lightly undertaken. Half of the gland has usually been removed, but some surgeons have been satisfied with tying three of the thyroid arteries in order to starve the growth. General anæsthesia is decidedly dangerous in these cases, and it is better to rely on local anæsthesia, either of the Schleich type, or by cocainization of the superficial cervical nerve, which can be exposed at the posterior border of the sterno-mastoid at the level of the thyroid cartilage, 2 or 3 drops of a 2 per cent solution should be introduced within its sheath. Patients are also very liable to syncope after the operation, and occasionally a curious train of symptoms supervenes within a few hours. The temperature rises suddenly to  $104^{\circ}$  or  $105^{\circ}$ , the pulse-rate is greatly accelerated, and the patient becomes delirious and finally comatose, dying in that state in about forty-eight hours. It is supposed that excessive thyroid toxæmia is responsible for these phenomena. The wound should be at once opened up, and probably a considerable quantity of a thin glairy fluid will be found within it. This should be soaked up by repeatedly packing the wound with dry sterile wool.

In the cases that recover, a gradual improvement usually shows itself, but the full benefit of the operation is rarely gained under six or twelve months, and even then the exophthalmos often persists. It is a little doubtful whether the improvement is really to be ascribed to the operation, or to the altered environment necessitated by it. The symptoms sometimes recur at a later date, and such cases have been treated by removing another portion of the gland.

Complete bilateral excision of the cervical chain of sympathetic ganglia has also been employed in this condition, and apparently with good effects, the mortality is decidedly less than in thyroidectomy.

**Malignant Disease of the Thyroid Body** is more frequently cancerous in nature than sarcomatous, usually taking the form of an adenoid

cancer, and always preceded by simple enlargement. The tumour grows rapidly, infiltrating the surrounding parts, and causing enlargement of the lymphatic glands, and secondary deposits in the viscera and elsewhere. The trachea is severely compressed, and in some cases perforated by the growth. The main vessels are frequently surrounded by the growth, and not merely displaced as in the simple variety. Myxœdema may ensue as a complication, owing to the total destruction of the glandular substance. Treatment by extirpation can only be undertaken in the early stages.

**Acute Goitre** is but rarely met with, consisting of a rapid enlargement of the thyroid body, which attains a considerable size in the course of a few days or weeks. It affects young subjects, and is generally fatal from asphyxia due to pressure on the trachea or spasm of the glottis. Comparatively little can be done for such cases, incisions into the fascia, division of the isthmus, and tracheotomy, have been suggested. In the latter case it will be necessary to have a specially long tube, which can be passed for some distance down the trachea.

**Inflammation of the Thyroid Body**, or acute thyroiditis, occasionally supervenes as a complication of an ordinary goitre. It is almost always infective in nature, the cocci reaching it from without, as in a punctured wound, or from within the body on a pyæmic embolus, suppuration being usually induced, it sometimes follows a blow, and may then be simple. The gland becomes enlarged, hot and tender, fever and rigors follow, and the presence of pus is indicated by superficial œdema and fluctuation. The early treatment consists in the application of fomentations and perhaps leeches, or in the use of an ice compress. The patient is kept in bed, purged, and carefully dieted. Under such a régime, resolution may occur, but if, as happens more frequently, pus forms, free incisions should be made.

**Accessory Thyroids** sometimes develop above or below the isthmus, or are closely attached to one of the lateral lobes. They are recognised by their connection with the thyroid body, moving up and down with it on deglutition, and if troublesome should be removed. They may also occur in any part of the thyro-glossal duct, and even in the base of the tongue, in that situation resembling a dermoid cyst.

## CHAPTER XXXII

### SURGERY OF THE AIR-PASSAGES, LUNGS, AND CHEST

#### Foreign Bodies in the Air-passages

ANY part of the respiratory tract may be partially or completely obstructed by the presence of some foreign body, the effect of which may be of greater or less gravity according to the situation, character, and size of the intruding substance

1 **In the Nasal Passages**, see p 831

2 Obstruction occurring at the **Rima Glottidis**, or pharyngeal entrance to the larynx, is usually due to attempts to bolt large masses of food, which, becoming impacted, may cause immediate death. A person, eating a meal voraciously, turns black in the face and falls off his chair, dead. A similar result has followed such a foolish act as attempting to swallow a billiard ball. If the obstruction is not complete, as when a plate of false teeth becomes impacted, great dyspnoea is caused, and absolute inability to swallow, the symptoms rapidly increasing owing to cedema of the submucous tissue of the glottis. Accidents of a similar nature may occur during chloroform narcosis, an epileptic fit, or drunkenness, some such substance as a plate of teeth being dislodged from the mouth, or a mass of food being vomited, and blocking the entrance to the larynx. The **Treatment** must be very prompt, since there is no time to lose. The mouth should be forced open by the handle of a fork or anything suitable that happens to be near, and the finger rapidly swept round the pharynx so as to dislodge the foreign body. Failing this, laryngotomy must be performed at once, and artificial respiration, if necessary, instituted. In less urgent cases there is time to remove the substance from the mouth with the assistance of a frontal mirror.

3 **In the Larynx** —A foreign body enters the larynx by inhalation during a deep inspiratory effort, when the glottis is widely open. Anything large is likely to be stopped above the larynx, and hence the type of foreign bodies we find in this region consists of small coins, buttons, nutshells, or a small tooth-plate. It may cause total obstruction and immediate death, or may enter one of the ventricles, and only produce partial obstruction, as evidenced by a sudden sense of suffocation, urgent dyspnoea, and a violent attack of coughing, attended perhaps by vomiting, such as occurs when anything is said to



have 'gone down the wrong way' The voice becomes croupy and hoarse, respirations stridulous, and any movement of the patient may for some time bring on a spasmodic fit of dyspnœa After a while the obstruction, which is at first partial, may become complete from œdema of the glottis, whilst perichondritis and ulceration or necrosis of the cartilages may be induced Laryngoscopic examination should reveal the situation of the intruding body The **Treatment** consists in attempting to remove it through the mouth with suitably curved forceps guided by a laryngoscope (endo-laryngeal method), or, failing that, a laryngotomy is performed, and the body dislodged if possible from below Should this not be successful, thyrotomy (p 913) must be undertaken

4 **In the Trachea**—To lodge in this situation a foreign body must be small enough to pass through the glottis, and not too heavy, otherwise it drops into one of the bronchi, it may become impacted, if it has jagged edges, but is not uncommonly free It may remain in one spot, only moving when the patient alters his position or coughs, and then the longer it stays, the less moveable it is, owing to its becoming embedded in mucus

The **Symptoms** may be described as those of obstruction, irritation, and inflammation During the passage of the body through the larynx, the patient suffers from a severe attack of spasmodic dyspnœa and coughing, which may last for some time Later on similar attacks may be induced by the foreign body being coughed up against the lower aspect of the vocal cords, and death has even resulted from its impaction in the larynx brought about in this way The irritation of the unusual occupant of the trachea produces tracheitis, with frothy expectoration and spasmodic cough, the lower it lies, the less the irritation, the mucous membrane being apparently less sensitive as it descends from the larynx **Treatment** consists in performing a low tracheotomy with a good-sized opening, and if possible removing the intruding body at once, or the patient may be inverted and the back well concussed in order to dislodge it Failing this, the wound in the trachea must be left widely open, by inserting a wire stitch through each side of the incision and tying the ends behind the neck, very probably the body will be expelled through it during an attack of coughing

5 To become impacted in a **Bronchus**, the foreign body must be sufficiently small to pass through the rima glottidis, and heavy and smooth enough to allow of its dropping down the trachea, the most common articles met with are buttons, pebbles, slate pencils, an O'Dwyer's tube, or the inner cannula of a tracheotomy-tube The right bronchus usually becomes obstructed, the reason for this being that although the left bronchus is more in a direct line with the trachea, yet the right is the larger, the septum between them lying to the left of the middle line A series of symptoms similar to those described above manifests itself, viz, obstruction, irritation, and inflammation The obstruction is twofold immediate, as a result of the passage of the body through the glottis, a condition due more

to spasm than to mechanical causes, and late, as a sequence of its lodgment in the bronchus. Even if at first the obstruction is partial, it soon becomes complete from swelling of the mucous membrane, for a time it is more or less valvular in character, allowing exit to air during expiration, but absolutely preventing its entrance. Collapse of that portion of the lung supplied by the affected bronchus is thus induced, as indicated by dulness and the absence of breath-sounds. Irritation and inflammation soon follow, resulting in bronchitis, the formation of a bronchiectasis, and peri-bronchial pneumonia, suppuration ensues, and the foreign body may be expelled sooner or later with a sudden gush of pus during a fit of coughing. Thus, in a case treated by the late Mr William Rose (grandfather to one of the authors\*), a beech-mast was inhaled in November, 1812, and was not extruded till May, 1822, the patient having in the meantime developed all the symptoms of a bronchiectasis. Sometimes the abscess may extend through the lung substance to the pleura, setting up a localized empyema, through which, when opened, the article is expelled. In other cases the lung becomes riddled with abscesses, and the patient dies of exhaustion.

**Treatment**—The position of the foreign body must be, if possible, ascertained by careful examination of the lungs, which may reveal a certain amount of collapse, whilst radiography may also be useful. A low and extensive tracheotomy is then performed, and the bronchi examined by a long bullet probe, suitably curved. The foreign body may thus be felt, and its removal accomplished by a delicate pair of forceps, a loop of wire, or a coin-catcher. Should it be impossible to remove it, the tracheotomy wound is left open for a time in the hope that inflammatory disturbance may loosen it, and it may be coughed up. Abscess of the lung, and localized empyema, are dealt with by incision, and it is possible that the foreign body may be removed by this means through the thoracic parietes.

### Injuries of the Larynx

Several conditions arising from traumatism of the upper air-passages have been already described, *e.g.*, fracture of the hyoid bone (p 482), and incised wounds, as in cut throat (p 895).

Occasionally the thyroid or other cartilages may be injured or fractured by direct violence, as in garrotting, causing local pain and hæmorrhage, and possibly some obstruction to the respiration. As a rule, no treatment is required beyond keeping the patient quiet, but should symptoms of dyspnœa arise, intubation or tracheotomy must be undertaken.

### Diseases of the Larynx

The study of laryngeal diseases can only be briefly referred to here, since it is now so extensive as to require special text-books.

Before the student can understand the subject, it is absolutely essential for him to master the use of the *laryngoscope*. This consists of a circular mirror set

\* *Lancet*, August, 1843

at an angle on the end of a metal stem, which is inserted into the patient's widely opened mouth in such a way that it rests against, and slightly elevates the soft palate. A beam of light is thrown into the mouth, either from an electric head lamp on the surgeon's forehead, or reflected by a frontal mirror from a suitable source of illumination. The patient's tongue, held with a towel, is drawn well forwards so as to enable the light to reach the larynx, the image of which is seen in the mirror. Considerable practice is needed in order to attain any facility in the use of this instrument as also to be able to recognise normal from abnormal structures. The use of cocaine to anaesthetize the fauces is in many cases indispensable. It must be remembered that the image is always inverted, so that the anterior portion of the larynx appears behind but there is no reversal of the sides.

**Acute and Chronic Laryngitis** are conditions of but slight surgical interest. The acute affection arises from cold or over-exertion of the vocal apparatus, and is characterized by aphonia (loss of voice) and cough. Locally, the vocal cords are seen to be hyperæmic and swollen. The *Treatment* is rather medical than surgical, although in children intubation or tracheotomy may be sometimes required.

**Diphtheritic Inflammation of the Larynx** is usually met with as an extension of a similar affection of the fauces. It gives rise to severe dyspnoea from obstruction in the rima glottidis, and, if the condition does not yield to the injection of the diphtheritic antitoxin, will probably require intubation or tracheotomy.

**Acute Oedematous Laryngitis**, or oedema of the glottis, is a condition of considerable surgical importance. *Causes*—(a) It is either secondary to some other laryngeal affection such as acute catarrhal laryngitis or acute perichondritis or (b) may extend from inflammatory conditions of neighbouring tissues, such as the root of the tongue or the submaxillary region, e.g., in cellulitis or Ludwig's angina, or it may be secondary to a retropharyngeal abscess. (c) It is also not unfrequently seen in children from drinking scalding water, as from the spout of a kettle, or sometimes in adults from swallowing corrosives. (d) It may result from the presence of a foreign body. *Characters*—The folds of mucous membrane extending on either side of the epiglottis both to the root of the tongue and backwards to the arytenoid cartilages become swollen and oedematous from a serous effusion into the submucous tissue (Fig 333). The same condition also involves the inter-arytenoid fold and the false vocal cords (superior thyro-arytenoid folds),



FIG 333 —ŒDEMA OF GLOTTIS FROM BEHIND  
(COLLEGE OF SURGEONS' MUSEUM)

The base of the tongue is seen to be enlarged and swollen and the aryteno epiglottidean folds are oedematous, so that the entrance to the larynx is represented by a mere chink.

extending down as far as the true cords. The process is checked at this level owing to the absence of submucous tissue, the vocal cords consisting of elastic fibres merely covered with a layer or two of squamous epithelium. The epiglottis becomes folded laterally upon itself as a leaf, merely leaving a valve like chink which permits of expiration, although considerably checking inspiration. The *Symptoms* produced by this condition are those of mechanical dyspnoea, to which, not unfrequently, spasm of the glottis is superadded, and this is sometimes of sufficient intensity to destroy the patient's life. There may be also some amount of febrile disturbance. The diagnosis is made either by passing the finger into the pharynx, when the rigid, swollen epiglottis can be felt or by laryngoscopic examination, when the slit like opening of the glottis, bounded below and behind by thickened œdematous folds of mucous membrane, can be seen. *Treatment* consists in scarification of the swollen tissues below and behind the epiglottis, which can be effected after spraying the parts with cocaine either by the finger nail or with a suitable knife guided by a laryngoscope. The usual result is a rapid diminution of the œdema, and additional relief may be gained by inhaling steam arising from hot water, to which some tinct. benzoini co. has been added. Fomentations or ice compresses applied externally are also

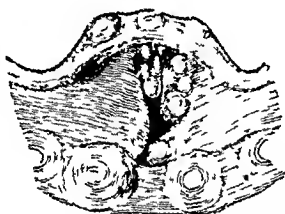


FIG 334—GUMMATOUS DISEASE OF THE LARYNX (TILLMANNS)

Small gummata are seen invading the mucous membrane of the epiglottis and front of the larynx.

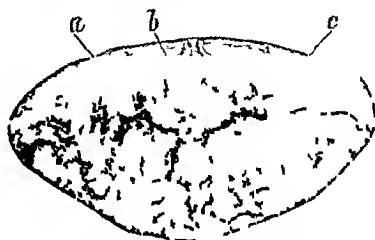


FIG 335—TUBERCULOUS DISEASE OF THE LARYNX, WITH EXTENSIVE ULCERATION IN FRONT AND BEHIND (TILLMANNS)

a, b, c, Remains of the epiglottis

useful, especially the latter. In more severe cases, and especially in children, intubation may be necessary, or the air passages may be opened below the obstruction, laryngotomy sufficing in adults, but a high tracheotomy being needed in children.

**Syphilitic Disease of the Larynx**—In the *secondary* stage, mucous tubercles or superficial ulcers occasionally form in the neighbourhood of the vocal cords, concurrently with the rash on the skin, and the formation of condylomata and mucous tubercles elsewhere. These are most likely to occur in costermongers or those who have to speak loudly and may then lead to a good deal of thickening of the cords. Apart from such cases it rarely causes much trouble beyond a little hoarseness. No special treatment is required, although possibly the parts, if ulcerated, may be brushed over with a solution of perchloride of mercury. In the *tertiary* period, diffuse gummatous infiltration or localized gummata may develop giving rise to destructive ulceration which especially affects the epiglottis and aryteno-epiglottidean folds, and may spread backwards and involve the whole glottis (Fig 334). Inflammation of the perichondrium is likely to follow, leading to necrosis of the cartilages. Hoarseness and dyspnoea are the chief symptoms of this affection, whilst considerable obstruction may be caused subsequently by cicatrization and laryngeal stenosis. *Treatment* consists in the administration of iodide of potassium and mercury, whilst ulcers may be sprayed with perchloride of mercury solution or dusted over with calomel or iodoform. Should urgent dyspnoea arise, tracheotomy must be undertaken.

**Tuberculous Laryngitis** (Fig 335) is occasionally a primary manifestation but is much more frequently secondary to phthisis arising from infection of the mucous membrane owing to the constant passage over it of the sputum. It

usually commences at the posterior part of the larynx in the neighbourhood of the arytenoid cartilages, as a submucous infiltration, which breaks down, and leads to typical tuberculous ulcers, similar to those occurring in other viscera (p 164). Considerable destruction of tissue ensues, involving the whole circumference of the larynx, and even leading to necrosis and destruction of the cartilages. Hoarseness, cough, and perhaps a certain amount of dyspnoea, in a patient suffering from phthisis, are the chief symptoms arising from this affection; the prognosis of which is always of a grave nature. *Treatment*—In phthisical patients local treatment is of but little avail, but where the disease is primary an attempt should be made to deal with it, such, however, can only be undertaken by the skilled laryngologist, as it consists in the topical application of caustics and antiseptics. Thyrotomy or subhyoid pharyngotomy has sometimes been practised, in order to attain this object more thoroughly.

Paralysis of the Larynx is observed in a variety of conditions, but is only of surgical interest when arising from injury or division of, or pressure upon, the recurrent laryngeal nerve. It may follow the removal of a goitrous tumour or of tuberculous glands, but is most commonly seen in connection with aneurisms of

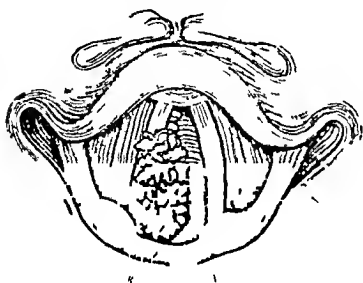


FIG 336—PAPILLOMATA OF THE LARYNX, SPRINGING FROM THE RIGHT VOCAL CORD (TILLMANN'S)



FIG 337—EPITHELIOMA OF THE LARYNX INVOLVING THE RIGHT VOCAL CORD AND BASE OF THE EPIGLOTTIS (TILLMANN'S)

the innominate or aorta, or tumours in the same neighbourhood, *e.g.*, cancer of the oesophagus, the actual pressure in the latter case being probably exercised by secondarily enlarged lymphatic glands. Paralysis from the above causes is generally unilateral, but if due to cancer both sides may be involved. The effect of complete paralysis of one recurrent laryngeal is to produce total immobility on the affected side of the vocal cord, which lies in what is known as the 'cadaveric position'—*i.e.*, midway between that in which it is placed during phonation and during inspiration. Not uncommonly the paralysis is incomplete and then merely affects the abductor muscle (the crico-arytenoideus posticus). The *Symptoms* arising from unilateral recurrent paralysis are often slight, the voice being usually but little modified, owing to the healthy cord being capable of passing across the middle line. If, however, both sides are completely paralyzed, absolute aphonia without dyspnoea, results, but if only the abductors are involved the voice may be unimpaired, although severe dyspnoea is often present, and this may prove fatal unless tracheotomy is promptly performed.

**Papilloma of the Larynx** (Fig 336) occurs in the form of wart-like masses usually growing from the true vocal cords, and giving rise to considerable hoarseness and perhaps some dyspnoea. They are recognised on laryngoscopic examination, and may be removed successfully by laryngeal forceps, after the parts have been efficiently cocaineized. It is recommended by some authorities to destroy the growth with a galvano cautery.

**Epithelioma Laryngis** occurs in patients over forty, originating as a papillary overgrowth, usually near the base of the epiglottis, or from the true or false cords (Fig 337). The tumour gradually spreads, both superficially and deeply, and may invade the cartilages, giving rise to necrosis. At a later stage it extends

beyond the limits of the larynx, attacking the base of the tongue, œsophagus, and even the lateral walls of the pharynx. As long as the disease is strictly limited to the larynx (intrinsic), the growth is often unilateral, causing hoarseness and aphonia, together with an irritable cough and the expectoration of blood stained mucus, which may be horribly offensive, it is associated with but little tendency to affection of lymphatic glands. When, however, the growth has extended to surrounding structures (extrinsic), lymphatic enlargement follows, and the disease runs its usual course, destroying life by dyspnoea and exhaustion. Pain is often a most distressing symptom being referred either to the larynx or pharynx, or, according to Ziemssen, not unfrequently to the ear.

*Treatment*—In the early stages it is possible that thyrotomy and efficient curetting and cauterization may suffice to bring about a cure. Later on, removal of one or both halves of the larynx will be required, and the operation may even include parts of the tongue and pharyngeal wall. Where, however, the disease has spread extensively, its total extirpation is rarely practicable, and all that can be done is to treat symptoms as they arise, and perform tracheotomy when necessary.

### Operations upon the Air-passages

1 **Subhyoid Pharyngotomy** was devised by Malgaigne, in order to provide access to the upper parts of the larynx in the treatment of foreign bodies or tuberculous disease. A transverse incision is made through the thyro-hyoid space, the pharynx is opened, and the epiglottis detached from the base of the tongue (Fig 338, I). It is a proceeding that is seldom undertaken, and scarcely necessary.

A much more satisfactory procedure is **Trans-hyoid Pharyngotomy**, in which the hyoid bone is divided in the middle line through a vertical incision extending from the symphysis menti to the thyroid cartilage.

The pharynx can then be opened either above or below the level of the hyoid bone, and the back of the tongue, the posterior wall of the pharynx, or the upper part of the larynx freely exposed. A preliminary tracheotomy is of course necessary. We have utilized this operation both for the removal of an epithelioma of the epiglottis and back of the tongue, and for enucleating a sarcoma of the posterior pharyngeal wall, and were much pleased with the approach given to these parts.

2 **Thyrotomy** (Fig 338, II) consists in a partial or complete vertical section of the thyroid cartilage, and may be required for the removal of foreign bodies or tumours, or for the radical treatment of laryngeal tuberculosis or cancer. Tracheotomy is performed as a preliminary measure, and the trachea plugged around the tube. An incision is then made in the middle line of the neck, extending from the hyoid bone to the cricoid cartilage. The crico-thyroid ligament is clearly defined and severed transversely, and the thyroid cartilage accurately divided by a knife, cutting-pliers, or fine saw. The lateral halves are separated, and the intra-laryngeal portion of the operation proceeded with. When closing the wound, the greatest care must be taken to bring the sides together in such a way that the vocal cords

are exactly opposite each other, or phonation will be considerably impaired. This is best ensured by making a horizontal cut across the front of the cartilage before dividing it.

3 **Extirpation of the Larynx (Laryngectomy)** is always a serious operation, which is never undertaken except for malignant disease. According to the site of the tumour the removal may be partial or complete, for a growth strictly limited to one side, extirpation of

that half will suffice, and admirable results have followed such treatment, distinct speech remaining, but if the whole larynx is removed, although the patient is subsequently able to whisper, phonation is impossible without mechanical assistance, whilst if the disease has extended beyond the limits of the larynx, operative interference is very unsatisfactory.

*Operation for Complete Extirpation*—A low tracheotomy should be performed, as a preliminary measure, and preferably a few days before, the trachea is plugged with a Hahn's tube or a Trendelenburg's air tampon at the commencement of the operation. An incision is made in the middle line of the neck from the hyoid bone to below the cricoid cartilage, at the upper end of which a transverse cut is made, extending as far as the sterno-mastoid muscle on either side. The soft parts are then stripped from the lateral borders of the thyroid cartilage with raspatories, the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles being divided at their insertions. Both the superior and inferior laryngeal vessels are tied and divided. Having thus freed the larynx anteriorly, the subsequent steps of the operation may be

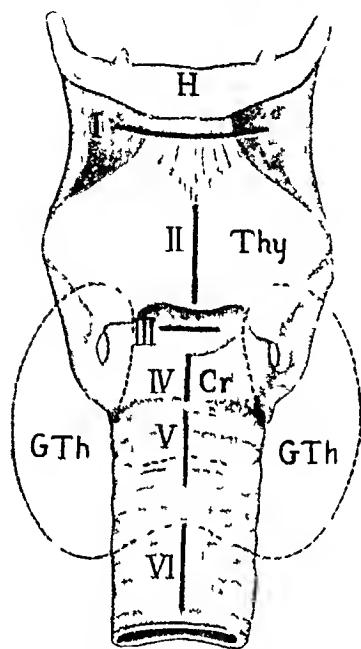


FIG 338.—OPERATIONS ON THE AIR PASSAGES

- I, Subhyoid pharyngotomy  
 II, thyrotomy, III, laryngotomy  
 IV, cricotomy, V, high tracheotomy  
 VI, low tracheotomy  
 H, hyoid bone, Thy, thyroid cartilage  
 Cr, cricoid, GTh, thyroid body

undertaken either from below upwards or from above downwards, the former proceeding is, to our minds, the better. The crico-tracheal membrane is divided, and the larynx drawn forwards, so as to enable the posterior attachments, *ie*, the connections of the constrictor muscles to the cricoid and thyroid cartilages, to be severed by scissors, the larynx being thus separated from the anterior pharyngeal wall, which must be left intact, if possible. The thyro-hyoid membrane and the base of the epiglottis are cut through, and the final steps of the operation consist in clearing the superior cornua of the thyroid, and dividing the lateral thyro-hyoid ligaments. The

operation is not particularly difficult or dangerous, provided that the surgeon keeps close to the larynx, and that the disease does not spread beyond its limits. When other structures, such as the base of the tongue, have been invaded by the growth, these steps must be modified so as to secure, if possible, complete removal of the disease. Finally, the transverse incision is sutured, but no stitches are inserted in the median wound, which is plugged, and allowed to heal by granulation. The upper end of the trachea should be secured to the skin at the lower angle of the wound, so as to prevent its retraction. The patient is fed *per rectum* for a few days, or by the passage of an œsophageal tube. At the end of a week the tracheotomy-tube is removed from its original situation, and inserted into the upper end of the trachea, the lower opening being allowed to close. When the wound has healed sufficiently, an artificial larynx can be inserted, by means of which the patient is able to speak in a somewhat reedy monotone, but it is seldom satisfactory.

Dr H. Lambert Lack advocates the total closure of all communication between the pharynx and the air-passages after laryngectomy. The upper end of the trachea is securely stitched all round in the lower angle of the incision and flush with the surface. The rent in the mucous membrane of the pharynx is then carefully closed, the wound is thoroughly disinfected, and the various layers of muscles are sutured together, as also the skin. Union by first intention can thus be attained, and the results have been most gratifying. Phonation is of course lost absolutely, but the patient can whisper, the necessary air-pressure being obtained in the dilated pharynx or upper end of the œsophagus.

If the disease is limited to one half of the larynx, the thyroid cartilage is cleft in the middle line, and the operation confined to the affected side.

4 Laryngotomy is never undertaken but for the relief of dyspnoea, arising from some sudden obstruction to the respiration, and is thus to be looked on as an operation of urgency. It is required in cases where the entrance to the larynx is obstructed by a foreign body, for spasm of the glottis, or for accumulations of blood in the neighbourhood of the larynx during an operation. It is readily performed by making a vertical incision over the situation of the cricothyroid membrane, which is then divided transversely along the upper border of the cricoid cartilage (Fig. 338, III), the sterno-hyoid muscles being, if necessary, drawn aside, and a tube inserted. Possibly the small crico-thyroid artery arising from the superior thyroid may require a ligature. In cases of great urgency, a simple transverse incision may be made with a penknife, and the larynx opened, the margins of the wound being held aside by a hairpin, or by the handle of a scalpel turned edgewise, whilst a toothpick will serve temporarily as a cannula. Whenever there is time to operate deliberately, a high tracheotomy is the better practice, since a tube inserted through the cricothyroid space gives rise to considerable irritation, and the voice may be subsequently impaired by the contraction of the cicatrix. A



special laryngotomy-tube is required, the lumen of which is oval and flattened from above downwards, not circular

In children, where there is but little space, the proceeding may be modified by division of the cricoid cartilage, and even of the first ring of the trachea, constituting what is known as *cricotomy* or *laryngo-tracheotomy* (Fig 338, IV)

5 **Tracheotomy**—The trachea usually consists of from sixteen to twenty rings, of which six or seven are situated above the sternum. The isthmus of the thyroid body usually covers the third and fourth rings, and the trachea may be opened either above or below it, or even sometimes behind, the isthmus being, if necessary, divided Tracheotomy is required in any condition in which there is serious obstruction to the respiration, e.g., various forms of laryngitis, and especially that due to diphtheria, for stenosis, tumours, and some forms of paralysis of the larynx, for the removal of foreign bodies, either in the larynx, trachea, or one of the bronchi, or for compression of the larynx or trachea by external tumours, such as an enlarged thyroid body It is also undertaken as a preliminary measure in operations on the mouth, tongue, pharynx, or larynx, in which there is any likelihood of asphyxia or secondary septic pneumonia, owing to the entrance of blood or septic discharges into the air passages. As a general rule, the high operation (that is, above the isthmus of the thyroid body) is to be preferred, but under special circumstances it may be advisable to open the trachea lower down. The risk attaching to the high operation is considerably less than to the low, but the opening is made nearer to any disease which may exist in the larynx. For the removal of foreign bodies from the bronchi or trachea, the low operation should always be employed.

The high operation (Fig 338, V) is performed as follows. The patient is placed on the back, with a sandbag or pillow beneath the neck, so as to throw the head backwards and put the structures on the stretch, and with the shoulders somewhat raised. Anæsthesia may be induced by chloroform, but it is unnecessary, and indeed unwise, to push the anæsthetic, since it is only needed for the division of the skin, where the dyspnoea is considerable, it is better to employ cocaine The head is held exactly in the middle line, and the surgeon feels for, and identifies, the cricoid cartilage. The incision extends from this structure downwards for about 1½ inches The superficial fascia is divided, and the interval between the sternohyoid muscles made out, so as to enable them to be separated one from the other. The edges of the wound are drawn aside by blunt hooks, which should both be held by one assistant, so as to ensure equable traction.

The isthmus of the thyroid body may now be seen, and, if projecting unduly upwards, should be pushed down after the fascia along its upper border has been transversely incised. The trachea is next clearly exposed by using the handle of a scalpel and dissecting forceps, and should be fixed and steadied by inserting a sharp hook into the lower border of the cricoid cartilage. The wound is freed

from blood as far as possible, and the trachea opened by inserting the point of the scalpel and dividing two of the rings from below upwards. A deep inspiration is usually taken at once, followed by a severe fit of coughing, and if the operation is undertaken for diphtheria the surgeon must be careful not to let any membrane which may then be expelled enter his eyes, nose, or mouth. The insertion of the tube is in many cases easy, in others a matter of some difficulty, a good deal depends upon the age of the patient, the urgency of the symptoms, and the depth from the surface at which the trachea lies. Anything which suffices to separate the lips of the tracheal incision, *e.g.*, the handle of a scalpel introduced and turned, a couple of hooks, or dressing forceps, will form an efficient guide for this purpose. The breathing soon becomes quiet and regular, and the tube is fixed in position by tapes passed through lateral openings in the face-

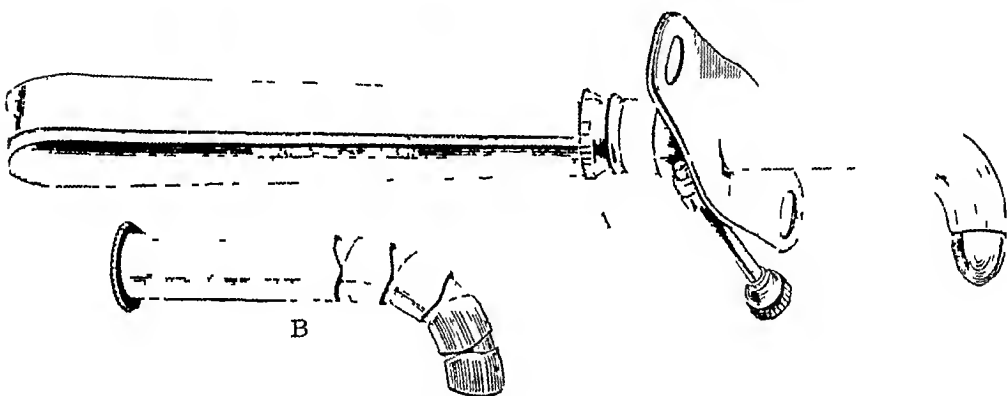


FIG 339 —DURHAM'S TRACHEOTOMY-TUBE (DOWN BROTHERS)

A, Outer tube with introducer, B, lobster-tailed inner tube

plate, and tied round the neck. No dressing is required for the wound except a few layers of gauze beneath the plate.

Low tracheotomy (Fig 338, VI) is performed in almost precisely the same way, except that the incision extends farther downwards, even reaching to the episternal notch, although the deeper part of the wound should never pass beyond a finger's breadth above the sternum, for the cervical fascia which is prolonged

of wounding the left innominate vein. The superficial layers of fascia are divided, and the sterno-hyoid and sterno-thyroid muscles drawn to either side by retractors. The inferior thyroid veins then come into view, and may cause trouble if they are distended with blood, as is so frequently the case in patients suffering from dyspnoea. They must be held aside by hooks, or divided between ligatures, and the deep layer of fascia behind them incised so as to expose the trachea, which is cleared, fixed, and opened in the same way as described above.

Many different forms of *tracheotomy-tube* have been used from time to time, but that most generally employed consists of a double

cannula, the inner portion of which can be readily removed and cleansed, it should always be longer than the outer, in order to prevent any plug of mucus being left within the outer tube on removal of the inner. A face plate, or some similar contrivance, is attached to the outer cannula, in order to fix and steady it. One of the best is that known as *Dunham's lobster-tailed tracheotomy-tube* (Fig 339, A and B), the rigid outer tube of this instrument is introduced by means of a flexible guide set on a handle, and passed within it. The guide is then withdrawn, and replaced by the inner flexible cannula (B). *Parker's tube* (Fig 340) also has a handy intro-

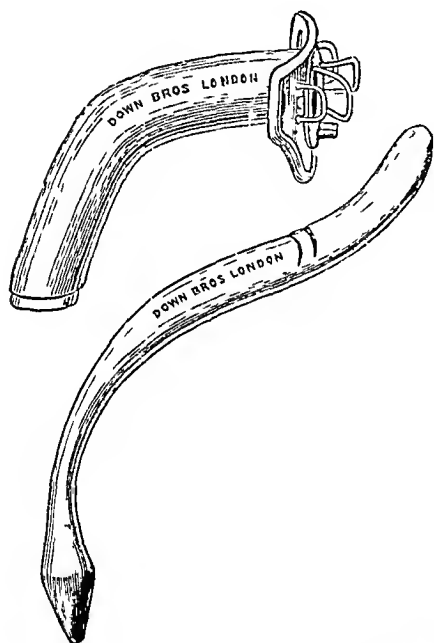


FIG 340—PARKER'S TRACHEOTOMY TUBE AND INTRODUCER (DOWN BROTHERS)

ducer, and is perhaps of a better shape than most of the others, following more closely the direction of the trachea. The *bivalve tube* is another useful instrument, the outer sheath consists of two lateral portions, attached to a single face-plate, and these can be pressed together, and hence with care easily inserted through the incision in the trachea. The surgeon must see that both limbs enter the trachea, as trouble has arisen from one limb passing outside, and the other inside, thus hindering the introduction of the inner tube. In cases of preliminary tracheotomy (p 854), undertaken to prevent the entrance of blood during operations, *Hahn's tube* may be used with advantage, in this the outer cannula is covered with a layer of compressed sponge which swells up from the absorption of moisture, and thus occludes the lumen of the trachea. *Trendelenburg's tampon* is recommended by some for the same object, the outer tube is here ensheathed with a thin indiarubber casing, which can be distended with air at will.

*Trendelenburg's tampon* is recommended by some for the same object, the outer tube is here ensheathed with a thin indiarubber casing, which can be distended with air at will.

**Difficulties and Dangers of the Operation**—Although the above description might lead the student to suppose that tracheotomy is an easy operation, this is by no means always the case, partly owing to the fact that it frequently has to be undertaken in a hurry, with perhaps inefficient assistance, and in a bad light, and partly owing to the intense vascular engorgement of the structures met with. A cool head and a steady hand are in such cases of infinitely more value to the operator than the most perfect anatomical knowledge. The following are the chief conditions which may lead to mistakes and accidents

(1) The administration of any general-anæsthetic is often inadvisable in semi-asphyxiated patients, since complete *cessation of respiration* may be caused thereby, possibly from spasm of the glottis. In such local anæsthesia must be relied on, and the employment of  $\beta$ -eucaine and adrenalin, as described in Chapter XLIV, has been most satisfactory.

(2) It is *not always easy to find the trachea*, especially in the necks of fat children, or where it is hidden by an unduly large thyroid isthmus, or possibly by the projection of the thymus gland into the neck. It is here most essential to remember the old adage, *In medio tutissimus ibis*, although occasionally the trachea may be displaced from the middle line by some external growth, and can then only be found by careful exploration with the finger.

(3) *Hæmorrhage* is generally troublesome. It is usually venous in character, arising either from the anterior jugular vein or from the inferior thyroid plexus. If possible, it should be controlled by pressure forceps before opening the trachea, but this is not absolutely necessary in urgent cases, since it usually ceases as soon as easy respiration through the tube has been established. The presence of the left innominate vein in front of the trachea must not be forgotten, although it but rarely reaches above the sternum. In about 8 per cent of all subjects an arterial twig (the *thyroidea ima*) courses upwards from the innominate artery along the trachea, to reach the isthmus of the thyroid body, if divided, it can be easily secured and tied. Should much blood be inspired, it may determine the occurrence of septic pneumonia at a later date.

(4) The possibility of the *entrance of air into veins* must not be overlooked, although it is an uncommon accident, since the intravenous pressure is so great.

(5) Not unfrequently considerable mischief has been done by an *incautious use of the knife*, especially if the operator forgets to fix the trachea with a sharp hook before opening it. In a child the trachea is small, and if it is moving rapidly up and down, as happens in urgent dyspnoea, or if the child is restless, and not completely under the influence of an anæsthetic, the difficulty is manifestly increased. Many accidents have happened from this cause, *e.g.*, wounds of the large veins or arteries of the neck, or even of the œsophagus or bodies of the vertebræ!

(6) As soon as the trachea is opened, a severe fit of *coughing* is induced, which is sometimes so prolonged as to interfere with the introduction of the tube. Under such circumstances the incision in the trachea may be opened up with a tracheal dilator, or by a pair of sinus forceps, and a few drops of cocaine swabbed over the mucous membrane.

(7) The *introduction of the tube* is a matter of no difficulty if the surgeon takes the precaution of not removing the hook until this is satisfactorily accomplished. Many mistakes have followed the non-observance of this rule, thus, the tube has missed the trachea altogether and passed into the fascial interspace in front, as also to one

or other side, as before mentioned, the outer portion of a bivalve tube has often been passed with one limb within the trachea and the other outside. A very dense diphtheritic membrane has also been a cause of difficulty, in that, although the tube has been really passed into the trachea, it has not penetrated the membrane, and thus has hindered rather than helped the breathing. In all cases of diphtheria the trachea should be freely opened, and the interior carefully examined by separating the lips of the incision before attempting to insert the tube. In order to prevent the downward passage of the membrane, some surgeons have recommended that the lower portion of the larynx should be carefully stuffed with antiseptic gauze above the tube.

**After-Treatment** —The patient is placed in bed, in a room kept at a uniformly warm temperature ( $75^{\circ}$  F), the air being moistened by the steam issuing from one or more bronchitis kettles, so as to make up for the absence of nasal and oral respiration. Draughts are excluded by curtains, and nothing should be placed over the entrance to the tube, so that respiration may not be hindered, nor the expectoration of mucus, false membrane, etc., prevented. One of the most frequent sources of extension of diphtheria to the lungs, or of septic pneumonia, is the re-inspiration of material which has been coughed out upon a portion of muslin or gauze, placed with excellent intentions over the mouth of the tube. A nurse should be in constant attendance on the patient, in order to wipe away all such material *as it is expelled*.

The inner portion of the tube is removed by the nurse, and cleaned two or three times a day, any inspissated mucus upon it being readily removed by the use of a solution of bicarbonate of soda (20 grains to 1 ounce). The outer tube is also removed once a day for cleansing purposes, but only by the medical attendant. Should the respiration become impeded by a collection of mucus in the trachea, a fine feather may be passed down the tube in order to clear it, but *never in diphtheritic cases*, for such a contingency special suction tubes have been devised. Attempts have been made to clear the passages by applying the lips to the tube, and removing the block by suction, such is, however, quite unjustifiable, and several promising house-surgeons have in this way lost their lives.

The period for which the tracheotomy-tube is kept in position varies in different cases, but its removal should always be undertaken at as early a date as possible, for fear of leading to impairment of the voice. In order to prevent this, the inner cannula is made with a hole in the upper end, so that part of the air may pass through the larynx. If the patient can then breathe comfortably when the finger is placed over the entrance to the tube, its presence is no longer necessary.

**After-complications of Tracheotomy** —(a) The tube may give rise to ~~ulceration of the trachea~~ if it is not correctly shaped. Thus, if too much curved, it tends to irritate the anterior wall, and cases are known in which it has caused death by perforation of the left

innominate vein. If insufficiently curved, the posterior wall may become affected, and the œsophagus laid open. In cases where a tracheotomy-tube has to be worn for a long time, it is advisable to make use of indiarubber tubes.

(b) Various forms of septic trouble may arise in the wound, leading to cellulitis and even secondary hæmorrhage, this is especially dangerous in the low operation, since the inflammation may extend to the mediastinal tissues. In cases of diphtheria the wound may also become affected with the disease.

(c) Inflammation of the trachea, bronchi, and lungs may result either from the entrance of cold, or unmoistened air, or from the inspiration of septic or diphtheritic material.

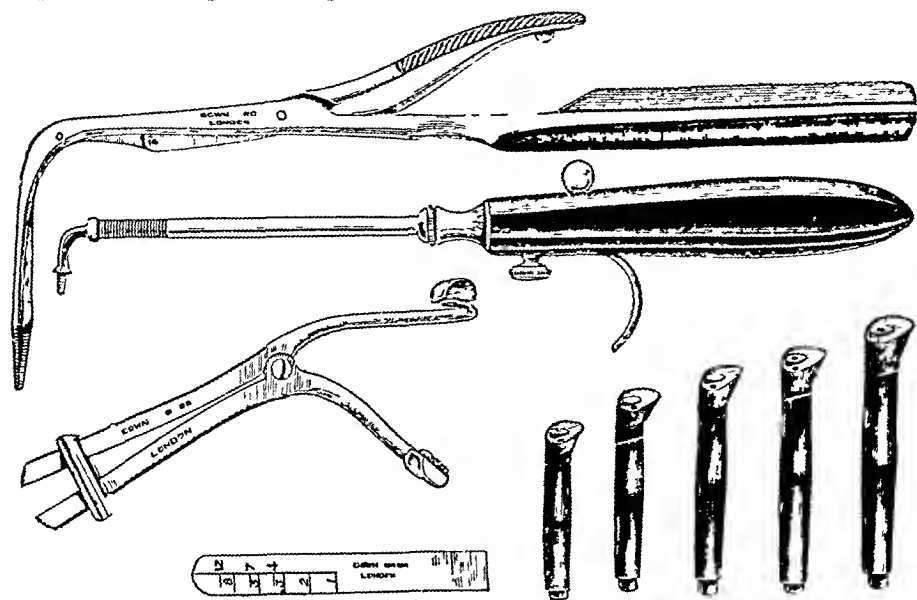


FIG 341 —O'DWYER'S INTUBATION APPARATUS (DOWN BROTHERS)

The cannulae are seen below on the right. A hinged inner tube passes throughout the length of each, and the upper end of this is screwed to the extremity of the introducer seen in the middle. When it has been inserted into the larynx, the trigger of the introducer is drawn and by this means the inner tube is loosened and can be easily removed, leaving the cannula in position. To extract the tube, the rectangular forceps represented at the top is utilized, the point of the forceps is inserted into the top of the cannula, and then by opening the blades the cannula is fixed and can be withdrawn. A useful type of unilateral gag is also represented, and a small gauge to indicate the size of cannula required at different ages.

(d) Difficulty is sometimes experienced in leaving off the tube, owing to the presence of granulations obstructing the lumen of the trachea, or to stenosis of the larynx from contractions or adhesions of the vocal cords, or even to paralysis of the abductor muscles, especially in diphtheritic cases. The trachea may also be kinked, and its calibre thus diminished, by cicatricial union of the skin and mucous membrane. The diagnosis of the cause at work in any

particular case can only be made by laryngoscopy, or careful examination of the wound and upper portion of the trachea. Granulations may be scraped away under an anæsthetic or destroyed by caustics, stenosis of the larynx is overcome by dilatation with an O'Dwyer's tube, whilst laryngeal paralysis must be treated by the use of electricity.

**6 Intubation of the Larynx** is a means of treating laryngeal obstruction which has been introduced in order to obviate the risk always present in tracheotomy. It consists in the passage through the mouth of a suitably curved tube into the larynx, by means of a specially contrived introducer. The best patterns to employ for the purpose are those known as O'Dwyer's tubes (Fig 341). The lower end of the cannula is oval, and not circular, and passes between the cords into the larynx, whilst the upper enlarged end lies over the entrance, it requires changing frequently in order to prevent erosion of the mucous membrane. It has been used with considerable success in cases of œdema of the glottis and laryngeal stenosis, but is scarcely to be recommended for diphtheria, owing to the risk of carrying the false membrane down with it.

### Affections of the Ribs and Sternum

Several forms of **Fracture** have been already described (pp 482 and 484).

**Acute Suppurative Inflammation** of these bones is very unusual. Occasionally an acute osteo-myelitis, running its usual course to necrosis, occurs in children, but the most common cause is typhoid fever (p 582). The affection is generally of a subacute type, and a more or less extensive cario-necrosis results. The special feature of the disease is the tendency of the bacilli to remain in a latent condition in the tissues, so that it is difficult to ensure a perfect cure apart from complete extirpation of the affected portion of bone. Mere scraping is rarely sufficient.

**Syphilitic Disease** is more common in the sternum than in the ribs. The upper part of the *sternum* is that usually involved, and the affection is characterized by a formation of gummata in and upon the bone, which erode it, usually in a pitted fashion, and may cause necrosis. The usual treatment with iodide of potassium and mercury is required, and sequestra will need to be removed. In connection with the *ribs*, syphilis appears as a tertiary periostitis or perichondritis. A fusiform swelling is produced in the course of a few weeks, with but little pain or tenderness, it may easily be mistaken for tubercular disease or a new growth, but the history of the patient may help one to a correct diagnosis, or the administration of iodide of potassium will clear it up.

**Tuberculous Disease** affects the ribs much more frequently than the sternum. In the *ribs*, tubercle may arise primarily as a periostitis or more often as an osteo-myelitis, implicating the medulla for some distance, but the disease is not unfrequently secondary to tubercle of

neighbouring parts, *e g*, the spine or pleura. Several foci may occur in a single rib, or several ribs may be involved at the same time. The disease is most commonly seen in young people, and affects either the back of the rib, not far from its vertebral attachment, or the costo chondral junction. The usual manifestations of tubercle in bone are seen, giving rise to caries or necrosis, and suppuration is common. The abscess cavity may be mainly external to the ribs, but is not unfrequently hour-glass shaped, a narrow neck connecting the cavities which lie inside and outside the chest. *Treatment* in these cases must be of a radical type. Mere scraping and disinfection are often inefficient, and the complete dissection of an extensive portion of the rib and of the abscess cavity attached to it is required.

In the *sternum* tubercle runs its usual course, and may present an abscess which points either in front near the middle line, or may come forwards from behind through an intercostal space. The treatment consists in cutting or scraping away the abscess wall, and in dealing with the bone, it may be necessary to remove some portion of it by gouge or cutting-pliers in order to gain access to the primary process.

**Tumours** of the ribs and sternum are usually chondromata or chondro-sarcomata, perhaps the former are a little more common in the ribs, the latter in the sternum. The patient complains of but little pain, and therefore the cases are usually late in coming under observation. Adhesions form externally to the pleura, and the lung itself may be invaded. In the early stages it is sometimes possible to remove them, although the lung is likely to collapse in the course of such a procedure.

### Surgical Affections of the Lungs and Pleural Cavities.

**Wounds of the Lungs** result from violence applied to the chest, with or without fractures of the ribs, or in consequence of penetrating injuries.

**Non-penetrating Wounds** consist either of laceration or contusion.

*Contusion of the lung* often follows some injury which is not sufficiently severe to fracture the ribs. The symptoms produced are severe pain in the side, with perhaps temporary shock and slight hæmoptysis. Some traumatic inflammation follows, both of the lung and of the pleura, as indicated by loss of resonance and possibly friction sounds. The treatment consists in keeping the patient quiet in a warm room, at the same time carefully regulating the bodily functions. Pain is often relieved by strapping the side of the chest.

*Laceration of the lung* is usually secondary to fracture of the ribs, especially from direct violence. The severity of the symptoms necessarily varies with the character and extent of the injury. The patient suffers from marked shock in severe cases, associated with pain in the side and dyspnoea. Evidences of *hæmorrhage* soon follow, either in the form of hæmoptysis or hæmothorax. If the wound is a



small one, the patient complains of an irritating cough, and brings up a good deal of blood-stained frothy mucus, but if the laceration is extensive, involving some of the larger pulmonary trunks, a quantity of pure blood may be ejected, even leading to death from syncope, or from asphyxia, owing to the blood filling the larger bronchial tubes. *Hæmothorax* may also be so excessive as to cause the patient's death from compression of the lung. It results in a gradually increasing area of dulness extending from below upwards, together with loss of breath-sounds and vocal fremitus, coming on soon after the injury without signs of inflammation.

Owing to the laceration of the pulmonary vesicles, air tends to escape either into the pleural cavity, giving rise to the condition known as pneumothorax, or into the cellular tissue of the body, constituting surgical emphysema. *Pneumothorax* is always associated with more or less collapse of the lung, and is almost certain to lead to considerable interference with respiration, and possibly to severe dyspnœa, or even orthopnœa. The air which finds its way into the pleura, having been filtered through the lungs, is free from organisms, and hence does not cause suppuration or putrefaction of the blood-clot present, unless bronchitis or some other suppurative condition has existed previously. The physical signs of pneumothorax consist in a high-pitched tympanitic note on percussion, and on auscultation amphoric breathing and possibly metallic tinkling. As soon as the wound in the lung commences to heal, the amphoric sounds disappear, the effused air is absorbed, and the lung gradually expands—a process which may take four or five days. If blood is also present in the thorax, a condition of hæmopneumothorax is produced, recognised by a splashing or succussion sound heard on shaking the patient. *Surgical Emphysema* almost always indicates a wound of both pulmonary and parietal layers of the pleura, which are slightly separated by air, constituting a localized pneumothorax. At each inspiration a fresh amount of air enters this cavity, and is expelled into the areolar tissues through the parietal wound at each expiration, being forced perhaps to a considerable distance from the spot where it commences, or even spreading over the whole body. It is of no serious significance, disappearing rapidly after the wound in the lung has commenced to heal, thus occluding the opened pulmonary alveoli. It is recognised by the parts becoming swollen and puffy, and giving a sensation of fine crackling crepitus when the hand is pressed over them. Occasionally emphysema may arise as an *interstitial* condition, when the parietal pleura has not been injured, the air escaping from the alveoli along the inter-alveolar connective tissue into the root of the lung, and then appearing first at the lower part of the neck.

Such are the ordinary phenomena observed in the early stages of a ruptured lung. The effects subsequently produced consist in a localized traumatic pleuro-pneumonia, associated with slight elevation of the temperature, possibly rusty sputum, and often severe dyspnœa. In the worst cases death may result from asphyxia.

**Penetrating Wounds of the Lung** are followed by very similar

effects, modified, however, by the fact that the external wound in the chest wall allows of the exit of blood, arising either from an intercostal artery, the internal mammary, or from the wounded lung, whilst it also permits the entrance of septic organisms with the air into the pleural cavity, and thus may change the character of the resulting pleuro-pneumonia from a simple to an infective inflammation. Empyema is consequently a frequent sequela, whilst the inflammation of the lung may be of a spreading nature, possibly terminating in suppuration or gangrene. Surgical emphysema is also induced by air being sucked into the wound during inspiration, and failing to escape during expiration, owing to the lips of the wound falling together. This condition may ensue even when the lung itself has not been damaged.

**Treatment** — When the rupture of the lung is due to a subcutaneous injury, the patient should be kept quiet in a warm room, and the side strapped. The compression of the chest wall must sometimes be omitted in patients where the irregular ends of fractured ribs, broken by direct violence, are driven inwards, for fear of increasing the mischief in the lung.

Persistent hæmoptysis must be treated by keeping the patient absolutely quiet, and allowing him to suck ice continually. Ergotin may be injected hypodermically, or a mixture of ergot, opium, and sulphuric acid administered, the opium is especially needed when great restlessness and irritability are present. Stimulants are necessarily contra-indicated, for fear of again starting the bleeding. Hæmothorax rarely needs special treatment, since the blood soon clots and is readily absorbed, but occasionally it may be so abundant as to compress the lung and lead to dyspnœa, and under these circumstances it may be necessary to open up the pleural cavity and remove it. Such must never be undertaken until sufficient time has elapsed to permit of thrombosis in the wounded vessels. Decomposition of the blood in the pleural cavity occasionally happens even in non-penetrating injuries, the bacteria reaching it either from the blood or from the lacerated bronchi, the suppuration and fever thereby induced necessitate the opening and drainage of the pleural sac.

Simple pneumothorax seldom requires surgical treatment, since the imprisoned air is quickly absorbed, and the lung re-expands, should this not occur, and if severe dyspnœa is present, it may be advisable to remove the air by aspiration. This may sometimes fail or the air may re-collect, and then the chest wall must be opened so as to give exit to the air. It is impossible for the lung to re-expand against the pressure of air confined in the chest, when an opening is made, the air can be driven out by a vigorous expiratory movement, such as coughing, which also forces air from the healthy lung into the wounded one when the glottis is closed.

Temporary dyspnœa may be overcome by the inhalation of oxygen, but when of a more decided character, and not due to any condition which can be removed, the essential treatment is to diminish the blood-pressure, and thus decrease the amount of blood carried to the

uninjured lung, so as to enable it to cope with the work of blood aeration. This may be accomplished by administering antimonial wine (10 to 15 minims every four or six hours) combined with full doses of liquor ammoniæ acetatis, but in urgent cases, where the patient is becoming cyanosed, and life is threatened by asphyxia, venesection must be adopted. The blood is withdrawn from the arm rapidly and freely, and as it flows the dyspnœa passes off. This may be repeated once or twice in addition to the use of the medicine before the full effect is obtained and respiration becomes unembarrassed.

The treatment of *penetrating wounds of the thorax*, involving the lung, is always a matter of considerable difficulty. The skin around the opening is carefully purified and shaved, if necessary, and a limited exploration of the wound is permissible, so as to determine whether portions of the clothing have been carried in, or a rib comminuted, all such loose fragments must be removed, as also any penetrating foreign body, such as a bullet, if readily accessible. The greatest gentleness must, however, be employed, and no attempt made to pass a probe into the pleural cavity, since it is easy to dislodge clots lying in the pulmonary tissues, and thereby restart the bleeding. If the wound itself needs sterilizing, it is perhaps best to touch it over with pure carbolic acid rather than to irrigate it, and then a dry antiseptic dressing is applied without drainage.

Immediate operative interference is only required under two conditions, viz, for hæmorrhage and for hernia of the lung.

*Hæmorrhage* after a penetrating wound of the chest wall may be derived either from a vessel in the parietes (intercostal or internal mammary) or from the lung itself. The recognition of the source of the bleeding is not always easy, but it is probably of *parietal* origin (a) if it is unaccompanied by hæmoptysis, (b) if it increases obviously at each systole, and (c) if it can be controlled by digital compression. The treatment of bleeding from the internal mammary and intercostal vessels has been already indicated (p. 291).

*Pulmonary hæmorrhage* is not so readily controlled, and various plans have been recommended. Probably the best method consists in keeping the patient absolutely quiet in the horizontal position, applying cold to the side, and giving hæmostatics, as indicated above for non-penetrating wounds. The effect of this will be to cause the blood in the pleural cavity to clot, and this acts as a tampon to the affected viscus, firmly plugging the external wound may limit the loss of blood and determine coagulation more quickly. In bad cases the hæmorrhage may cease only when the patient is in a condition of profound collapse, intravenous or hypodermic infusion of hot saline solution may then suffice to tide over the period of danger and lead to a successful result.

The question of opening the thorax by turning up a large flap of the chest wall (including portions of several ribs) so as to deal directly with the injured lung has been raised of recent years, and several cases in which it has been undertaken have been recorded. Further

experience will probably decide that such a procedure is quite unjustifiable except in very unusual circumstances

The later treatment of these cases is much the same as for simple non-penetrating injuries. Should symptoms of septic pleurisy follow, the wound must be freely opened, a portion of rib being excised, if necessary, and the cavity washed out and drained, as for empyema.

**Hernia of the Lung**, or pneumocele, is a rare condition in which a portion of the lung protrudes through an opening in the thoracic parietes beneath the uninjured skin. It may occur suddenly, as the immediate consequence of a laceration of the intercostal muscles and pleura, or more gradually, being then due to the yielding of a cicatrix. It is most usually seen about the fifth intercostal space, but has been known to occur in the root of the neck from a lesion in the dome of the pleura. It is recognised by the appearance of a rounded swelling, increasing in size on coughing or making expiratory efforts, and possibly disappearing entirely on holding the breath. It imparts a crepitant feeling to the fingers when compressed, and on auscultation a loud vesicular murmur is heard. As a rule, no treatment is advisable in this condition beyond the application of a pad or truss.

A similar condition, arising as a complication of an open wound, is termed a **Prolapse of the lung**. An attempt should always be made to return the protruded viscus, and to prevent its recurrence by suturing the aperture through which it has escaped. If left unreduced, it is very likely to become gangrenous from strangulation, and should then be removed by the application of a ligature, the wound being subsequently closed.

**Empyema**, or suppuration within the pleural cavity, results not only from traumatism, but also as a sequela of a simple pleurisy, or as a complication of various affections of the lungs, whilst a basal empyema is not an uncommon result of intra-abdominal suppuration. Bacteriological research has demonstrated that in children more than half of the cases are due to the pneumococcus, either alone or less often in conjunction with streptococci, whilst in adults the streptococcus is the commonest organism. A description of the physical signs and symptoms belongs rather to the physician than to the surgeon. It will suffice to mention here that in a total empyema the affected side of the chest does not move on respiration, whilst the intercostal spaces may bulge, on percussion the side is dull, except perhaps immediately below the clavicle, where tympanitic resonance may be elicited. On auscultation breath-sounds are absent, except in the vertebral groove, where bronchial breathing may be heard. The loss of vocal fremitus is also an important sign. A certain amount of fever and dyspnoea is usually present in cases of empyema, whilst the heart and other viscera may be displaced. Left to itself, an empyema usually finds its way to the surface, and perhaps most commonly bursts through the fifth or sixth costal interspace, though sometimes through the second in front, owing to the perforating vessels being larger here than elsewhere. Occasionally a localized empyema is met with, giving rise to similar effects, but on a smaller scale. When

situated on the left side in close proximity to the pericardium, the movements of the heart may be transmitted through the fluid to the surface, causing a pulsation which can be seen or felt (*pulsating empyema*)

In the early stages the pleura is but little altered in structure, although a certain amount of lymph may be deposited on it, in old-standing chronic cases it becomes very dense and firm, owing to a development of fibro-cicatricial tissue, whilst the surface is converted into a layer of granulation tissue, similar to that found in all chronic abscesses. The lung collapses and retreats backwards towards the spine, at first its alveolar texture remains unaltered and the early removal of the exudation enables it to re-expand, as a result of the atmospheric pressure. In chronic cases, however, there are two hindrances to this expansion, viz, the density of the thickened visceral pleura, which resists the atmospheric pressure, and the infiltration and sclerosis of the lung tissue itself. Under these circumstances, even when the exudation is entirely removed, the lung may remain collapsed, and Nature then attempts in several ways to remedy the mischief and obliterate the pleural cavity. (a) The opposite lung undergoes expansion and hypertrophy, and together with the heart projects over to the opposite side, (b) the abdominal viscera and diaphragm are displaced upwards, (c) the chest wall falls in, and the spine becomes laterally curved, with its convexity to the sound side, and (d) there is an exuberant growth of granulation tissue from the surface of the pleura. In a certain proportion of cases these structural changes suffice to determine a cure, but in others a cavity still remains, lined with thickened pyogenic membrane, and discharging pus or serum, according to whether or not sepsis is present. Under these circumstances extensive operative interference is necessary.

The **Diagnosis** of empyema is readily made by attention to the physical signs, and confirmation of such an opinion can be obtained by puncture with a sterilized hypodermic syringe. A medium-sized needle should always be employed for this purpose, and it is well to insert it along the top of a rib after drawing the skin up or down, so that on removal a valvular puncture results. The character of the organisms contained in the sample of pus thus withdrawn should, if possible, be ascertained, since it has been proved that the **Prognosis** depends much on this point. Thus, an empyema due to the presence of pneumococci, presumably following a pneumonia, runs a mild course, and is readily cured, even by aspiration alone, one due to the ordinary pyogenic cocci is more acute, and requires drainage with or without resection of a piece of rib. The presence of tubercle bacilli renders the outlook much more serious, whilst the addition of septic organisms to any of the above aggravates the process and much impedes a cure. The chronicity or not of the affection is also a most important element in the prognosis, since the later the treatment commences, the denser are the adhesions which bind down the lung, and the less the chance of its re-expansion. The

character of the pus also varies with the organisms present, with pneumococci, the pus is yellow, creamy and laudable, whilst there is usually an abundant production of fibrinous false-membranes, when of streptococcal origin, the pus is usually thin and oily

**Treatment** therefore should never be delayed, the earlier it is undertaken, the better the results

*Aspiration* may be adopted in the first instance, but is generally to be regarded as of an exploratory nature, though a cure will occasionally follow when the empyema is of pneumonic origin. It is, however, sometimes of value in order to relieve for a time the pressure on the other lung and the resulting dyspnoea, and thus allow of the administration of an anæsthetic for the more serious subsequent operation

*Drainage* of the pleural cavity through an external incision is the treatment almost invariably necessary, and as a matter of mechanical convenience it is usually advisable to resect a portion of a rib in order that the drainage-tube may not suffer compression, especially is this the case in children. The best site for opening a complete empyema has been much discussed, and it is probable that subsequent drainage is facilitated by making the opening well back, *e.g.*, in the ninth space just external to the scapular line. Possibly in children with a pneumococcal empyema, which is not likely to need lengthy drainage, a more convenient site may be selected in the fifth or sixth interspace, just behind the mid-axillary line, apart from these cases, an incision here is usually ineffective, and will require a subsequent counter-opening further back. An incision is made along the course of a rib about  $1\frac{1}{2}$  inches in length, and the periosteum stripped up from both the superficial and deep aspects of the bone, so as to enable a curved raspator to be passed beneath it, at least 1 inch of the rib is then cut away with bone pliers. The parietal pleura is opened sufficiently to enable the finger to be introduced and the cavity explored, as also to allow of the removal of flaky masses of fibrin. A large drainage-tube is inserted, just long enough to project into the pleural cavity, and the wound immediately covered, so as to prevent as far as possible the entrance of unfiltered air.

Formerly it was considered desirable to wash out the pus, but it has now been demonstrated that this is unnecessary and occasionally dangerous. Several cases of sudden death have followed this practice, probably due to reflex irritation of the vagus. In chronic cases, where sepsis has been admitted, irrigation is often beneficial, but the following points must be attended to (i) The fluid employed must be unirritating, though sterile, (ii) it must be at the temperature of the body, neither too hot nor too cold, (iii) it must not be injected with such force as to impinge against the pleura or against the upper surface of the diaphragm, and (iv) free exit must be given to it, so as to prevent tension from accumulation within the pleural cavity.

If such treatment is undertaken early, the lung may be expected to expand quickly, the discharge steadily diminishing, and the

wound healing without delay, but, as we have already explained, this does not always occur, and then a fistula persists, leading into a cavity lined with a thick pyogenic membrane, discharging a variable amount of pus. The best means of obtaining a cure in these cases consists in removal of the rigid external wall, as by *Estlander's operation*, which is characterized by the excision of portions of ribs comprising the outer wall of the cavity. It is usually carried out through a vertical incision in the axillary line, the ribs being freed from their periosteal connections, the amount excised necessarily varies according to circumstances, and is in some cases very extensive. The fistulous track is enlarged, and the interior of the pleura carefully curetted and washed out, so as to remove all necrotic and degenerating tissue, the parietes are then allowed to fall back into contact, if possible, with the deeper layer, a drainage-tube is inserted, and the side firmly bandaged. A modification of this proceeding is known as *Schede's operation*, in which not only are the ribs removed, but also the intervening tissues, so that the subcutaneous or muscular structures in the flaps are laid down upon the prepared surface of the deeper layer of the pleura.

Necessarily, either of these methods of treatment is associated with considerable deformity, and also with a terrible weakening of the side, and plans have been suggested to obviate this by removing portions of a number of ribs before and behind, so as to leave the intervening segment free to collapse without totally destroying the osseous thoracic boundary. Another proceeding that has been recently practised with occasional success is the stripping of the thickened pleura away from the collapsed lung, so as to enable it to expand once more (pulmonary decortication). Obviously such a procedure could only be of value when the compression of the lung has not been followed by sclerosis, whilst infection of the pulmonary tissue has resulted in grave inflammatory disturbance and even death. It is more than doubtful whether this proceeding is ever justifiable.

**Pneumotomy**, or incision of the lung, has been undertaken for not a few pulmonary lesions, and the results obtained have been rather variable. 1 For *tuberculous cavities* it is of little use. They are usually situated at the apex of the lung and drain well, the original disease is not removed, and the general health is frequently so impaired that the shock of the operation hastens the inevitably fatal issue. Hence it is only required in cavities located in the lower half of the lung, which drain badly, and the difficulty of diagnosing such a condition is considerable. 2 For *bronchiectases* pneumotomy, though *prima facie* desirable, has given but little benefit, since it is uncommon for only one dilatation of the bronchus to exist. In suitable cases, however, where there is a good deal of foetid secretion, which is with difficulty expelled, it may be useful. 3 *Gangrene* of the lung and *pulmonary abscess* usually follow acute septic pneumonia in debilitated individuals. The expectoration is abundant and extremely offensive. The localization is made partly with the stethoscope, but mainly with the exploring needle. The gangrenous area is often near the base of the lung. Operation is frequently successful. Of course, the

pulmonary abscesses of pyæmia, being multiple, are not suited to operative treatment 4 In *hydatid* disease of the lung, incision and drainage have so considerably reduced the mortality that this method of treatment should alone be adopted

As to the *technique* of the operation, the first thing is to locate the mischief, and this is effected partly by a careful attention to the physical signs, partly by the use of an exploring needle or syringe. An incision is then made, and a portion of one or more ribs removed. If the lung is adherent to the thoracic walls, and shows no signs of retracting, the operation may be continued, but if no adhesions are present, it may be well to pack the wound with gauze for a day or two, so as to determine their formation and thus shut off the pleural cavity. The lung itself may be punctured with sinus forceps introduced along an exploring needle, and then opened, or may be incised with a cautery. The abscess or other cavity is thus emptied of its secretion, and a drainage-tube inserted. As a general rule it is unwise to scrape or irrigate it, for fear of a communication existing with any of the larger bronchi.

**Pneumectomy**, or excision of a portion of the lung, has been attempted in a few cases of tuberculous disease limited to the apex, the operation is, however, quite unjustifiable, since, if the affection is localized to the apex, it can often be cured by hygienic measures, whilst if it is more diffuse it cannot be extirpated. Primary malignant tumours of the lung, moreover, are usually central, and the diagnosis can rarely be made early enough to warrant an attempt at removal. The only conditions under which it is justifiable to excise portions of lungs are (a) when a hernial protrusion has become strangled through a small opening, and cannot be reduced, and (b) when malignant disease of a rib has invaded the superficial portion. In the former case, the base of the protrusion is transfixed and ligatured prior to being cut away, in the latter, the disease is snipped away with scissors, and bleeding stayed by cautery, ligature, or plugging.

### Wounds of the Heart

**Wounds of the Heart** and great vessels are so usually fatal either immediately or within a few hours, that it is unnecessary to discuss them here in any detail. If the patient does not die at once, he suffers from intense shock and prostration, combined with a weak and turbulent action of the heart, great pain in the chest and dyspnoea, whilst the pulse is scarcely to be felt. Free hæmorrhage occurs if there is an external wound, but if the opening in the pericardium is small and valvular, the heart's action may be brought to a standstill by the pressure of the blood within. Should the patient survive, pericarditis generally supervenes, and is often of a purulent type. As to *Treatment*, the great essential is to keep the individual absolutely quiet, and with the head low. The external wound should be purified, but during the stage of primary shock no attempt should be made to explore it, either by finger or probe, for fear of dislodging



a clot. Later on the question of exploration may be raised, and more than one case has now been published in which the surgeon has successfully sutured a stab-wound in the ventricle. To expose the heart for this purpose it is usual to turn up a trap door flap of the chest wall, including portions of the fourth and fifth costal cartilages and ribs. Other cases are reported in which a wound of the heart has healed spontaneously, and the patient survived for many years.

**Effusion into the Pericardium**, whether serous or purulent, may occasionally require surgical treatment in order to relieve symptoms of cardiac failure, due to the pressure of the exudate. For serous pericarditis all that is needed is to aspirate the cavity. This is usually undertaken close to the left border of the sternum in the fifth interspace, or  $1\frac{1}{2}$  inches from the left margin of that bone through the fourth or fifth interspace, so as to avoid the internal mammary trunk, which courses down about a finger's breadth from the border.

For suppurative pericarditis an incision may be made in the same situation after removing the fourth or fifth costal cartilage, the cavity washed out, and even a drainage-tube inserted. Care must be taken to prevent infection of the mediastinal tissues, and this can sometimes be accomplished by stitching the pericardium to the parietes before opening it.

### Asphyxia

**Asphyxia**, or **Apnœa**, is the term applied to indicate the condition arising from interference with or stoppage of the respiratory act. If this has not proceeded to any great extent it is termed **Dyspnœa**, when, however, the obstruction is so marked that the patient is obliged to maintain the upright sitting position, the term **Orthopnœa** is applied to it.

The Causes of asphyxia may be classified as follows.

1. Conditions arising from the presence of abnormal contents within the air passages, *e.g.*, foreign bodies, blood clot or pus from the bursting of an abscess or aneurism, serum as in œdema of the lung, mucus or muco-pus, as in bronchitis, the consolidated exudation in pneumonia, diphtheritic membrane, or irrespirable gases, *e.g.*, nitrogen, hydrogen, carbonic acid gas, etc., as in suffocation. Death by drowning usually arises from a similar cause, *viz.*, the replacement of air by water in the respiratory passages.

2. Causes arising in the walls of the air passages, such as diminution of their lumen from inflammatory congestion, as in œdema of the glottis, cicatricial stenosis, the presence of new growths, or the displacement of parts, as in cut throat or the falling back of the root of the tongue after partial excision of that organ.

3. Extrinsic causes, or those arising outside the air passages, *e.g.*, in the neck strangling, hanging, garrotting, etc., the presence of tumours, such as goitres or aneurisms, a retro-pharyngeal abscess or tumour, and, under exceptional circumstances displacement backwards of the sternal end of the clavicle. Within the thorax gradually increasing obstruction to the respiration may be caused by the presence of tumours, aneurisms, or effusion into the pericardium or pleura.

4. Nervous causes, *e.g.* paralysis or spasm of the larynx, and paralysis of the diaphragm, either from peripheral lesions, such as the pressure of aneurisms or tumours on the nerve trunks, or from central causes, such as a lesion in the upper part of the spinal cord or medulla. It may also arise from paralysis of the respiratory centre as from an overdose of chloroform.

5. In many forms of cardiac disease the lungs may become engorged with stagnant blood, leading gradually to dyspnœa, orthopnœa, and finally asphyxia, owing to the increasing difficulty in eliminating the excessive accumulation of carbonic acid.

The **Treatment** of the different conditions giving rise to asphyxia cannot here be dealt with *in extenso*. We can only indicate the general plan of treatment to be adopted. A rapid examination is at once made to ascertain, if possible, the cause of the mischief, and whether its onset has been gradual or sudden. If it has been gradually developing, it is not uncommonly due to some thoracic condition which cannot be relieved, if, however, its onset has been sudden, and not the result of any evident lesion, the neck and chest should be bared, and examined for signs of traumatism, the mouth opened, the tongue drawn forwards, and the glottis examined with the finger to see that the passages are clear. The patient should, if necessary, be removed into fresh air, and artificial respiration at once commenced. Breathing can sometimes be excited by alternately dashing hot and cold water over the thorax, whilst electric stimulation of the phrenic nerve may also be undertaken, one electrode being placed over the neck, and the other on the epigastrium. The administration of oxygen instead of air is useful during the earlier stages, whilst if the condition is due to cardiac disease with distension of the right side of the heart, venesection holds out the best hope of relief. Obstruction within the larynx needs tracheotomy or intubation, as also other conditions associated with pressure on the trachea.

**Artificial Respiration** is required in a variety of surgical conditions, and can be undertaken by what is known as Sylvester's method. In this the patient lies on his back, with a pillow beneath the shoulders, the mouth opened, and the tongue drawn forwards. The arms are then grasped just above the elbows and drawn upwards above the patient's head, so as to expand the chest through the action of the great pectoral muscles. This position is maintained for about two seconds, and then the arms are lowered to the side, and pressed firmly against the ribs, so as to determine a forcible expiratory act. At the end of about two seconds more the arms are again elevated and the same cycle passed through. This should be repeated about fifteen times a minute, and the operator must be careful not to use too great violence, or to unnecessarily hurry over it, as harm rather than good thereby results.

Another less satisfactory method consists in alternately compressing the lower part of the thorax and abdomen with the hands, so as to drive out a certain amount of air, and then by suddenly relieving the pressure the elastic expansion of the chest walls draws in a fresh supply.

In the **Treatment of the Apparently Drowned** the air-passages must be cleared as quickly as possible. During the struggles of the drowning man water enters the trachea and is churned up with mucus, saliva, and perhaps blood into a froth which does not easily escape, but must be slowly squeezed out by the application of pressure to the back, whilst the patient is lying face down. At the same time artificial respiration must be maintained, and it is obvious that Sylvester's method is not an ideal plan under these circumstances. Dr R. L. Bowles has elaborated a procedure for these cases which admirably suits their requirements, and we have much pleasure in quoting his instructions *verbatim*, and introducing the illustrations which he has kindly placed at our disposal.

'Treat the patient at once and on the spot. Undo any tight clothing. Kneel and place the patient on the right side and quickly wipe out the mouth and throat.

'If there are no signs of breathing, spread a handkerchief on the ground where the patient's mouth will come, and carry out

'*Movement No. 1*—Turn the patient flat on the stomach, and at once with widespread hands press gently but firmly for three or four seconds on the back of the ribs on both sides to squeeze out the froth, fluid, or foul air (Fig. 342). Then suddenly remove the hands

to allow the entrance of air by the natural recoil of the ribs, and proceed to

'*Movement No 2*—With the right hand grasp the patient's left shoulder, with the left hand take his left wrist, place it against his



FIG 342—TREATMENT OF THE APPARENTLY DROWNED—MOVEMENT NO 1



FIG 343—TREATMENT OF THE APPARENTLY DROWNED—MOVEMENT NO 2

hip, and roll him towards you on to his right side (Fig 343) This movement should take about two seconds

'Repeat first and second movements in succession for ten minutes

or more (if necessary), when some of the froth or fluid will have drained away from the lungs, and then proceed to

'*Movement No 3*—Each time the patient is rolled from the stomach on to the right side, take hold of the left or uppermost arm and raise it above the head in a line with the body. This movement expands the chest still more and allows air to enter the upper left lung (Fig 344). Then bring the arm down to the side, roll the patient on to the stomach, and begin again at movement No 1, and



FIG 344—TREATMENT OF THE APPARENTLY DROWNED—MOVEMENT NO 3

continue each movement in succession as before, for an hour or until signs of natural breathing begin

'Always turn the patient on to the right side, never on the left, and under no circumstances on the back. From time to time wipe away froth from the mouth and nose

'The neck should be kept fairly straight and the chin away from the breast-bone, the head may then be left to take care of itself, and the face will take no harm, as it will remain chiefly on its side, and yet perfect drainage will be ensured'

## CHAPTER XXXIII

### DISEASES OF THE BREAST

Congenital Malformations of the breast are much more common than is usually supposed. One or more accessory breasts (*polymastia*) or

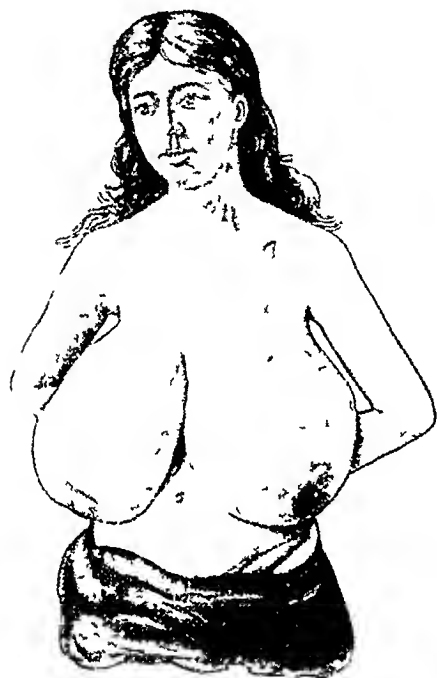


FIG 345 —DIFFUSE HYPERTROPHY OF THE BREASTS

It occurred in a girl aged sixteen and a half years, and both organs had to be removed. The left breast weighed 9½ lbs, the right breast 9 lbs.

nipples are found either below the normal one or just above it, but sometimes they have been found in the axilla, on the outer side of the thigh, or other curious situations. They are often of a most rudimentary nature, but in a few cases they have secreted milk. The existence of these structures probably explains the occasional origin of cancer in unusual situations, such as the axilla. Very rarely the breasts are entirely absent (*amazia*). Occasionally the male breast becomes enlarged to the size of an ordinary virgin's breast (*gynecomastia*), the organ is usually functionless, although lactation has been known to occur, and the overgrowth mainly affects the stroma. The condition may be associated with imperfect or irregular development of the sexual organs.

**Diffuse Hypertrophy** of the breast (Fig 345) consists of a general enlargement of the organ, both gland substance and interstitial tissue participating in the process, and hence the breast becomes firm and indurated. It may be uni- or bi-lateral, perhaps more frequently the latter, and generally occurs in adolescents. The size varies considerably, but the breasts may become enormous,

hanging down by their weight, and perhaps to such an extent as to rest on the knees of the patient when sitting. They are usually painless, although sometimes neuralgia is noticed. Functionally they are useless, as even if the patient becomes pregnant, secretion of milk but rarely occurs. No cause can be assigned for the overgrowth, and the only treatment is amputation, when the increased size is causing discomfort.

### Affections of the Nipple

**Fissures of the Nipple** (cracked nipples) seldom occur apart from lactation, and may usually be traced to a want of care and cleanliness on the part of the mother, associated with a tender condition of the skin, which might have been prevented by bathing the parts during the later weeks of pregnancy with spirit, so as to harden them. The actual lesion is brought about by leaving the nipples wet after nursing. The superficial layers of epithelium become macerated, and are easily rubbed off, thus exposing the more delicate and sensitive deeper parts, which are irritated and inflamed by repeated acts of suction. As a result, nursing becomes painful, and if persisted in, the wound may be infected, the inflammation spreading to the breast substance along the ducts or lymphatics, or extending along the superficial lymphatics to the axillary glands.



FIG 346—CHANCRE OF THE NIPPLE (FROM PHOTOGRAPH AND SKETCH LENT BY PROFESSOR RUSHTON PARKER OF LIVERPOOL)

**Treatment** — The best way to prevent the occurrence of cracks is to bathe the nipples with some dilute antiseptic, such as boric acid lotion, immediately after nursing, and then to dry them thoroughly. If at all tender, a little powdered boric acid and starch may be dusted over them in the intervals. When a fissure has formed, it should be dressed with cooling or antiseptic lotions—e.g., *lotio plumbi* or *lotio aciduli borici*. Sometimes more stimulating applications are required, such as a solution of sulphate of copper, or even of nitrate of silver. It is also recommended to paint the sore with equal parts of glycerine and sulphurous acid.

**Eczema of the Nipple** may be of a simple nature, needing nothing

but ordinary treatment, or it may take on special features, being then known as **Paget's Disease** (*dermatitis maligna*), a condition really due to a carcinomatous development in the skin. It is seen, but very rarely, in parts other than the breast. It presents a smooth, red, raw surface, discharging an abundant yellowish viscid fluid, and may occasionally spread widely beyond the areola. It is almost invariably followed by a cancerous tumour beneath the nipple, which may resemble either a duct cancer or an ordinary scirrhus. No local treatment is of any avail, and the disease, when once recognised with certainty, is best treated by removal of the breast and axillary glands.

**Abscess of the Areola** is not uncommon in young girls about the age of puberty, arising in the sebaceous follicles, and requiring no special notice.

**Chancre of the Nipple** (Fig 346) is rarely seen in the mothers of syphilitic children (Colles's law, p 152), but much more commonly in wet nurses. It usually presents as a shallow ulcerated surface with a well-marked, raised, and indurated border. Not uncommonly the condition is symmetrical.

**Primary Tumours of the Nipple** are met with, such as papilloma, sebaceous cysts, and occasionally epithelioma.

### Inflammatory Affections of the Breast

**Acute Mastitis** is naturally most often observed in puerperal women, owing to the sudden establishment of function in the breast after the birth of a child, and to its maintained activity during lactation. It results most commonly from a sore or cracked nipple, through which ~~pyogenic organisms~~ find their way into the breast substance, either along the lymphatics or the gland ducts. In the former case the inflammation is mainly interstitial in character, the pus diffusing itself widely between the lobules, in the latter the pus forms primarily within the alveoli of the glandular substance, but subsequently spreads beyond it. Simple obstruction to one or more of the ducts from inflammation of the nipple, without any external wound, also determines an attack of mastitis, which is frequently non-suppurative in character. In non-puerperal women acute mastitis may result from injury, or may be pyæmic in origin. Occasionally a metastatic inflammation of the breast occurs after the disappearance of the parotid swelling in mumps, whilst in girls about the age of puberty a subacute inflammation, involving both the breast and areola, and even terminating in suppuration, has been observed. In ~~newly-born infants~~ a similar inflammation, occasionally running on to suppuration, has been seen, possibly resulting from an infection of the gland ducts during birth with cocci from the maternal passages. A slight enlargement, with congestion of the breasts, often occurs after birth, and may be due to, or is certainly aggravated by, the foolish habit followed by ignorant midwives of pulling or forcibly squeezing them in order 'to break the nipple-strings.'

**Signs and Symptoms**—An inflamed breast is characterized by the

organ becoming swollen, acutely painful, and tender. The gland lobules are felt to be enlarged and indurated, whilst if lactation is progressing, the secretion is to some extent impaired, but owing to the inability of the mother to allow the child to relieve the organ, on account of the pain produced thereby, considerable tension results from accumulation of milk. If suppuration follows, the skin over the breast becomes red and œdematous, and, according to the situation of the pus, three different forms of acute abscess of the breast are described. (a) *Supramammary abscess* is the term applied to a collection of pus in the subcutaneous tissues, it is often entirely unconnected with the organ, or may originate in the superficial lobules. It is strictly limited, ~~and does not burrow deeply~~, coming readily to the surface. (b) An *intramammary abscess* is that most commonly met with, the pus developing within, and distending the lobules, or infiltrating the cellular tissue around them, it is usually diffused widely throughout the organ, and may point at several spots. When very acute, or in debilitated women, especially if it has been allowed to progress without treatment, the inflammatory process may actually determine ~~gangrene of the glandular tissue~~. (c) A *submammary abscess* is one forming in the cellular tissue beneath the breast. It may spread from the deep lobules, but more frequently arises in connection ~~with disease of some of the adjacent ribs or cartilages, or as a cellulitis~~. In these cases the breast is pushed forwards, and becomes prominent, floating, as it were, on a bed of pus. The abscess usually points at the periphery of the organ, ~~perhaps in several places, but most commonly at the lower and outer quadrant~~.

Inflammation of the breast occurs in women who are anæmic and weakly. Even the simple forms are associated with some fever and malaise, and this becomes greatly exaggerated if suppuration ensues, owing partly to the severe pain thereby induced, and partly to the absorption of toxins.

The **Treatment** of simple acute mastitis consists, in the first place, in supporting the inflamed gland by means of a sling or bandage, and in binding the arm to the side, so as to keep at rest the pectoral muscle, on which it lies. Fomentations are then applied, and any tension due to retained secretion is relieved by the breast-pump. The bowels are opened, and the patient placed on a light and nourishing diet, whilst stimulants and tonics, such as iron and quinine, may be judiciously administered.

As soon as the acute stage has passed, friction with warm oil, or the ununction of a belladonna ointment, is advisable.

When suppuration is threatening, the breast may be poulticed until fluctuation is detected, but under no circumstances must the abscess be allowed to burst into the poultice, and thus become septic. If such a practice is permitted, chronic suppuration ensues, and the breast may become riddled with sinuses. The most rigid asepsis must be maintained in these cases, and as soon as pus is evidently present, an incision should be made to permit of its escape. In the *supramammary* variety it matters little in which direction the cut is



made, since the pus is always superficial to the breast tissue. In the true *intramammary abscess* the incisions should radiate from the nipple. One or more may be needed, and these should be made with a free hand, so as to allow of the insertion of the finger, and the opening up of any pockets or lobules which are distended with matter. A drainage-tube is inserted for a time, and gradually shortened day by day, until its entire removal is permissible. ~~When the chief incisions are needed above the nipple, it is often wise to make a counter-opening in the lower half of the breast, and generally on the outer side, to permit of more efficient drainage.~~ With such treatment the best of results may be attained, and it is interesting to note how quickly the contour of the breast is restored, and how slight is the permanent injury inflicted on the parts. The *submammary abscess* is best opened towards the lower and outer side, but also at any spot where pus points.

If septic sinuses persist after an abscess has burst, their orifices should be enlarged, and their walls thoroughly scraped and disinfected, deep cavities should be efficiently drained and stuffed with gauze, so as to ensure the wounds healing by granulation.

**Chronic Mastitis** occurs in two forms—one, a localized affection of one segment of the breast (chronic lobar mastitis), the other involving the smaller lobules and interstitial tissue (chronic lobular or interstitial mastitis).

1 **Chronic Lobar Mastitis** is by no means unfrequent as a result of imperfect involution of the organs at the cessation of lactation, but may arise from blows or squeezes, and especially in young women, it may also follow a subacute or acute attack, which has not ended in suppuration. It is characterized by an enlargement of one or more lobes of the organ, which are usually tender, and often excessively painful, the pain being of a neuralgic character, and increased during menstruation. The condition is of comparatively little importance, but may give rise to a great deal of anxiety and worry. All that is necessary in the shape of **Treatment** is to support the part and keep the arm at rest in a sling, whilst an ointment containing belladonna, or a belladonna plaster, may be applied.

2 **Chronic Lobular or Interstitial Mastitis** is an affection of much interest, which occurs most frequently in women with small or atrophic breasts, who have passed, or are near to, the climacteric, being then merely an exaggeration of the sclerosis which occurs normally at that epoch. It is, however, sometimes met with at an earlier age. It may involve the whole of one or both breasts, or may be limited in its development to a portion of one breast, and is then likely to be mistaken for a malignant tumour. **Pathologically**, it is characterized by diffuse overgrowth and infiltration of the connective tissue, which becomes sclerosed and thickened. This is associated with well-marked epithelial proliferation, so that sometimes in the earlier stages the acini are filled with a thick cheesy or grumous material which can be squeezed out in thread-like masses, often of a dirty brown or greenish-yellow colour. Cysts are formed in the

gland tissue, partly by liquefaction of this proliferated epithelium, partly by exudation into the acini of serous fluid, which is unable to find an exit owing to the pressure of the interstitial growth. Such are known as 'involution cysts,' and the fluid contained therein is usually clear and limpid, but may be brown and turbid, from admixture of blood, intracystic growths are not present. As a rule, many of these cysts are scattered widely through the breast substance, but they are small and insignificant, occasionally one or more of them become notably enlarged, and give the patient the impression of a tumour.

**Clinical History**—The condition often passes unnoticed in the early stages, until a distinct lump has formed, which is nodular and indurated to the touch, and often very painful. The breast may be somewhat enlarged, and there is, perhaps, some retraction of the nipple, owing to contraction of the interstitial tissue, but this is by no means an essential feature. A scanty serous discharge from the nipple is sometimes noticed. The skin seldom becomes adherent to the swelling, whilst the lymphatic glands in the axilla may be enlarged and tender owing to sympathetic irritation. On careful examination of the breast, the affection is rarely limited to one particular region, for although a distinct enlargement of one portion may be present, yet the whole organ feels more or less 'lumpy,' and not unfrequently the other breast participates in the same change. Small, rounded, elastic spots can often be detected on careful palpation, and indicate the presence of cysts. There may be but little pain, although this is sometimes one of the most marked features of the case, it is of a neuralgic type, and usually increased at the menstrual periods.

If left to run its course, the disease may remain much in the same condition for many years, and even in time disappear, but more frequently it slowly progresses, and then results in one of three conditions. (a) *General atrophy*, the breast becoming shrunken, hard, and nodular. (b) More frequently *general cystic disease* follows, a condition in which the organ becomes transformed into a number of cysts held together by dense connective tissue. (c) There is some question as to whether or not *cancer* is a sequela of this disease, but there is abundant evidence to prove that any continued source of irritation in an organ like the breast renders an individual with a cancerous tendency more liable to its development.

The **Diagnosis** is sometimes easy, but the condition often simulates somewhat closely a scirrhus tumour. The chief points of distinction, however, lie in the facts (i) that the whole breast is more or less involved, (ii) that the opposite organ is very often similarly affected, (iii) that enlargement of the axillary glands is less common than in scirrhus, and even if enlarged they are not hard, as in the latter disease, (iv) that the skin is usually free from the mass, (v) that the tumour is never adherent to the pectoral fascia, nor is it of the stony hardness of a scirrhus, and (vi) that it is often more disseminated and less defined than a cancerous growth. (vii) Moreover, on careful palpation with the flat of the hand, it is often impos-

sible to make out any distinct lump, the so-called tumour merging into the surrounding tissues, this never occurs in scirrhus, the growth always being easily detected with the flat of the hand. Small cysts can also be felt as localized elastic spots in the inflammatory mass. Of course it is possible for the two conditions to co-exist, and in doubtful cases an exploratory incision, and microscopic examination of a portion of the tissue, can alone be depended on.

**Treatment**—In the early stages friction with some sedative application may be used at the same time that the breast is supported, and freed from the irritation of badly-fitting stays. Firm and equable pressure, as by strapping, is also useful in some cases, whilst iodide of potassium may be administered. If a definite tumour is present, or if many cysts can be detected, and especially if the patient is anxious and worried about herself, it is wise to remove the affected portion, or even better to excise the whole breast, especially when there is a family history of malignant disease.

**Localized or Encysted Chronic Abscess** is usually associated with pregnancy, and is characterized by the formation of an indurated mass in the breast substance, which slowly softens, giving rise to a sense of fluctuation, although when the abscess walls are very thick, as is often the case, it may be exceedingly difficult to detect this. Retraction of the nipple is not uncommonly present, and the axillary glands may be enlarged. The condition has frequently been mistaken for a tumour, but is recognised from it by its incorporation with the breast substance, by its lack of definition, and by the fact that on careful examination elasticity can be felt at its centre, which is almost always less resistant than the margin, whereas the opposite is the case with a tumour. In cases of doubt the insertion of a grooved needle or an exploratory incision will settle the diagnosis. Some few of these chronic abscesses of the breast are of a tuberculous nature.

**Treatment** consists in opening the abscess cavity, scraping out its interior, disinfecting with pure carbolic acid, if tuberculous, and draining or stuffing it.

**Diffuse Tuberculous Disease** of the breast is not so uncommon as was formerly supposed. Scattered nodules of caseous material are developed in the interacinous tissue, which break down into pus, and come to the surface at various spots. The breast may thus become riddled with sinuses discharging caseous pus. It may be associated with tuberculous disease of the lungs, whilst a like affection may arise secondarily in the axillary glands, possibly in some cases the primary trouble lies in the glands, the breast being subsequently involved.

**Treatment** should be carried out, if possible, by incision, scraping, and purification of the cavities, but if the tuberculous foci are multiple, it is wiser to amputate the breast.

Occasionally a *chronic tuberculous submammary abscess* forms as a result of a similar affection of the ribs or costal cartilages. It develops slowly, pushing the breast forwards, and is easily recognised,

although the causative lesion can only be ascertained by exploration. It must be opened thoroughly, and its wall scraped and disinfected, whilst attention is also directed towards the affected bone.

**Syphilitic Diseases of the Breast**—As already pointed out, a primary sore may be met with on the nipple, secondary mucous tubercles, or condylomata, are found in a similar situation or beneath a pendulous breast, whilst superficial and deep gummata have in rare cases formed in the tertiary period of the disease.

### Cysts of the Breast

When the structure of the breast, its abundance of ducts and alveoli, and its complex lymphatic distribution are considered, it is not surprising that many different forms of cystic change are associated therewith. The following are the more important.

1 **Acinous or Retention Cysts** arise, as the name suggests, from some obstruction to the ducts or lobules, whereby the secretion of the organ is unable to escape. They are met with most frequently in women during or after the puerperal period, a milk cyst, or *galactocoele*, being then produced. It usually results from compression of one or more of the ducts, connected with a sore nipple, and contains inspissated milk, it forms a rounded swelling, and is located near the nipple. The wall is lined with cuboidal or columnar epithelium, according to whether a portion of the lobule or the duct itself is implicated, if, however, it attains any great size, the epithelium may become flat and squamous. This is surrounded by a fibro-cicatricial layer, the thickness of which increases with the chronicity of the case. It is treated by laying the part open, removing the contents, and stuffing or draining the cavity.

Similar glandular cysts form, as already described, in the course of chronic interstitial mastitis, and are then known as *involution cysts*, in long-standing cases, general cystic disease of the breast may supervene.

Retention cysts have also been described as resulting from irritation of the nipple, as, for instance, when a young non-pregnant woman constantly puts a baby to her breast, the organ becomes enlarged, the epithelium proliferates, and a thin serous fluid is secreted, which does not entirely escape and by its distension of the lobules gives rise to what may be termed *irritation cysts*. They may in time undergo spontaneous absorption, but Erichsen describes a case of this nature in which the swellings did not disappear until the patient subsequently became pregnant.

Again, one frequently finds cystic dilatation of the ducts and lobules arising in connection with certain tumours of the breast, such as duct papilloma, duct cancer, or cysto-adenoma. In the latter cases hæmorrhage from the contained growth is often seen, giving rise to a blood stained discharge from the nipple. A scirrhus growth also occasionally starts from the wall of an acinous cyst.

In most of these retention cysts, discharge from the nipple occurs on squeezing the organ.

2 **Interacinous Cysts** develop in the interstitial tissue of the breast

(a) **Serous Cysts** originate, it is supposed, from a dilatation of lymph spaces. They may be uni- or multi-locular, perhaps more frequently the latter. They are lined by a smooth, shiny layer of endothelium, and contain serum, perhaps blood-stained, and in old-standing cases cholesterine, being separate from the gland substance, they never give rise to a discharge from the nipple, and intracystic growths are unknown. They are usually surrounded by a wall of connective tissue which may become exceedingly thick and dense. Occasionally, however, they project under the skin, and if the walls remain thin, fluctuation, and even translucency, can be observed, leading to the condition sometimes badly termed a *hydrocele of the breast*.

The **Diagnosis** of a serous cyst, if the wall is thick, is often a matter of considerable difficulty, as it resembles in many ways a scirrhus. It is recognised, however, by the facts that the growth is incorporated with the breast substance, usually occurring near its under surface, that on careful examination an elastic resistance is transmitted to the fingers, quite distinct from the stony hardness of a scirrhus, that there is no retraction of the nipple and no enlargement of the axillary glands, whilst, as a rule, the patient complains of but little pain. The diagnosis in cases of doubt may be readily determined by inserting a grooved needle, or by an exploratory incision, which should be made of sufficient depth to ensure the thorough division of the mass, for fear that a small cyst surrounded by walls of fibrous tissue, half an inch, or even an inch, in thickness, should be mistaken for a solid tumour.

**Treatment**—Although it may suffice to lay the cavity open and drain it, it is decidedly wiser to remove it completely.

(b) **True Hydatid Cysts** are occasionally met with, manifesting the general characteristics described at p. 220.

3 Cysts may also arise in connection with cancerous or sarcomatous tumours, from degeneration of tissue in the former case, and from hæmorrhage into the substance of the latter.

4 **Dermoid Cysts** are described, but it is a little doubtful whether old galactoceles have not been mistaken for them.



## Tumours of the Breast

In investigating any case of tumour of the breast, the surgeon must never arrive at a hasty conclusion, but only give an opinion as to its nature after careful and detailed examination. Thus, the age and previous history of the patient should be considered, as also the family history. Simple tumours generally arise at an earlier date than the malignant, whilst the sarcomata usually affect younger individuals than the carcinomata. There can be little doubt, moreover, as to the occasional tendency of tumours to run in families. The length of time for which the swelling has been observed should be ascertained, and whether or not it varies in size at the menstrual

periods The general appearance of the patient should be noted, as also the fact whether or not pain, local or neuralgic, is experienced It is not unusual for pain to be referred to that part of the shoulder supplied by the posterior division of the second intercostal nerve, the anterior branch of which goes to the breast A careful inspection of the organ should then be made, comparing it with the opposite breast, so that any signs of asymmetry may be noted Dimpling of the skin, projection of the tumour or of the whole gland, and the situation and condition of the nipple, are the chief points to which attention should be directed Examination of the tumour with the flat of the hand, accompanied by gentle pressure of the finger-tips, must then be undertaken, it is not enough to pick up the breast substance between the fingers, as thereby false impressions are obtained The relation of the tumour to the gland, its shape, its consistency, whether fluctuating or not, and its mobility on superficial, deep, and surrounding parts, should all be investigated To this end the breast must also be examined with the arm raised well above the head, so as to put the fibres of the pectoralis major on the stretch, transverse movement of the organ across the fibres is always possible, unless the growth is fixed to the thoracic wall, movement in the direction of the fibres is at once limited if the tumour has invaded the muscle, or even if the overlying fascia is seriously involved Finally, the lymphatic glands in the axilla must be carefully examined, as also, in suspicious cases, the supraclavicular glands and the opposite breast and armpit

The chief types of tumour met with in the breast may be arranged in three groups the adenomata, the sarcomata, and the cancers A few other conditions have been observed, but are so rare that they need no special description, *e g*, lipoma, fibroma, chondroma, and osteoma

**Adenoid Tumours of the Breast**—This group includes the two forms of fibro-adenoma (the hard and the soft) and the cysto-adenoma All are characterized by the existence of spaces lined with epithelium, which does not extend beyond the basement membrane The spaces may contain a variable quantity of fluid, and in some cases intracystic growths are a prominent feature The interstitial tissue is sometimes of a very embryonic type

A pure **Adenoma** is said to occur, but is very uncommon Its texture would be identical with ordinary mammary tissue, and its characters with those of a fibro-adenoma, except that it is a little softer

The **Hard Fibro-adenoma** (or **Adeno-fibroma**) is the most common mammary tumour met with in young people before the age of thirty, it is often attributed to a blow or squeeze, and doubtless correctly It occurs as a more or less rounded or oval mass, which, if placed superficially, moves freely in the breast substance, and, indeed, may be described as floating in it (Fig 342), if situated deeply, it still appears freely moveable, but its definition is less evident Sometimes several such growths are found in the same breast A fibro-adenoma is usually firm and more or less elastic in consistency, of slow growth, and it may be either painless, or in anæmic and neurotic

women exceedingly painful, the pain often increasing at the menstrual periods. There is no concurrent enlargement of the axillary glands, unless arising from other causes, and no retraction of the nipple, with which it is entirely unconnected, the skin over it does not dimple. The general health is unimpaired unless the patient is suffering from an associated anæmia. On section after removal the tumour is of a grayish-white colour, becoming pink on exposure to the air. It is more or less foliated in texture, being compared by Virchow to the section of a cabbage, no juice can be obtained on scraping the cut surface with a scalpel, although on pressure some fluid of a thick glutinous or mucoid nature may escape. Microscopi-

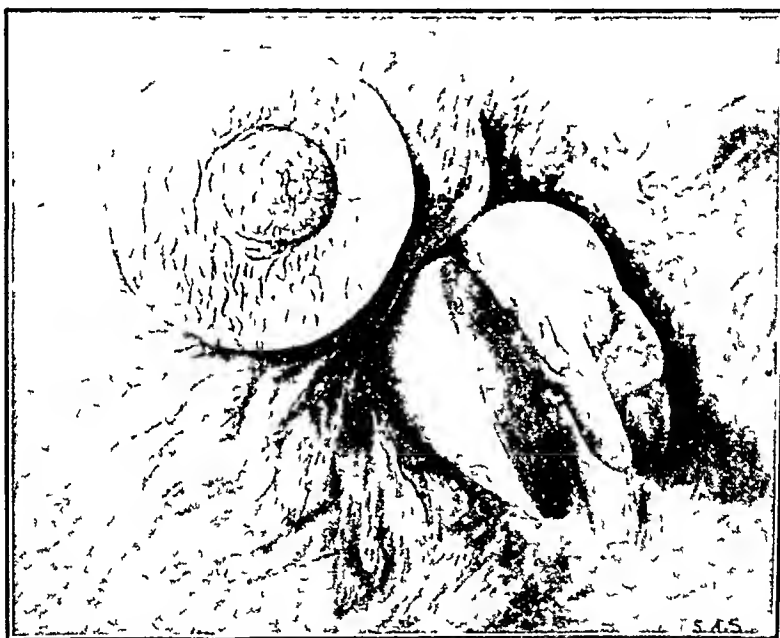


FIG. 347.—FIBRO ADENOMA MAMMÆ (FROM MUSEUM OF ROYAL COLLEGE OF SURGEONS)

cally, the tumour consists of imperfectly developed glandular elements, surrounded by a considerable amount of firm interstitial tissue, but ducts are never present. The tumour is distinctly encapsuled, except at the one spot, through which vessels enter, and at which it is connected with the neighbouring mammary tissue. It is stated that fibro-adenomata are occasionally converted into sarcomata, thus changing their type from simple to malignant, the evidence, however, as to this is not conclusive.

The **Diagnosis** is readily made if the above signs are considered. An adenoma differs from chronic interstitial mastitis or a serous cyst by its exact definition and free mobility, whilst from malignant tumours it is distinguished by its slow rate of growth, and its freedom from adhesions either to the skin or to surrounding parts.

The **Treatment** consists in its removal, which is easily effected by cutting down upon the tumour in a direction radiating from the nipple, until the capsule is reached, when the mass is enucleated from its surroundings with a few touches of the knife. When the growth is present in the upper half of the breast, a crescentic incision may be made along its lower border, and by burrowing upwards under the organ, the tumour can be removed from behind, the scar will be subsequently hidden.

The **Soft Fibro adenoma** differs from the above mainly in the increased rate of growth, in its soft consistency, and in the fact that the interstitial tissue is of a more embryonic character, and, indeed, is often of a mucoid nature, it is sometimes incorrectly termed an adeno-sarcoma. It usually occurs in women at a somewhat earlier period of life than sarcoma or cancer—viz, between the ages of twenty-five and thirty-five. It may consist from the first of a localized tumour, increasing rapidly in size, or it may possibly commence as a hard fibro-adenoma, which, after remaining quiet for a time, takes on a more active development. It remains, however, throughout its course strictly encapsuled, and when large may lead to pressure-atrophy of the true gland substance. It is soft and elastic in consistency, usually painless, and freely moveable on the surrounding breast tissue. The skin over it remains healthy, although distended and atrophic when the tumour is of large size, the nipple shows no sign of retraction, the axillary glands are not involved, and there is no systemic invasion. On removal the section is similar to that of a fibro-adenoma, but cysts are often present, as also areas of mucoid softening, somewhat resembling sago. It can be readily removed in its entirety, and does not tend to recur.

**Cysto-adenoma** (*Syn* **Cysto sarcoma**, **Adenocoele**, **Intra-canalicular Adenoma**, etc.) is a condition characterized by a marked development of intracystic growths, fibro-papillomatous in nature, within the dilated acini of a newly-formed mass of adenomatous tissue, or within the smaller ducts (Fig 348). It usually has a definite capsule, and then the normal gland tissue may be pressed aside, and perhaps atrophies. Several cysts are, as a rule, present, and may be of great size, the intracystic growths also varying in amount. Sometimes there is only one large cauliflower-like mass in a cyst, sometimes there are several smaller pedunculated growths. They are covered with epithelium, which is cuboidal or columnar, they are exceedingly vascular, and hæmorrhage into the cavity of the cyst frequently occurs, as also a blood-stained discharge from the nipple. They are due to a proliferation of the interacinous tissue, which pushes the epithelial wall of the duct or acinus before it. The tumour produced is irregular in outline, owing to the projection of the cysts, it is usually painless, and unaccompanied by enlargement of the axillary glands, if of large size, blue veins are seen coursing over it. In the later stages the capsule becomes adherent to the integument, and, finally, owing to the pressure of the tumour, the skin may give way, allowing the growth to protrude. This will be followed by the



development of a fungating mass, which bleeds readily, and becomes extremely offensive. With care a probe can be passed between the intracystic portion of the growth and the thinned and stretched skin, which has merely given way, and is not incorporated with it, this fact is a ready means of distinguishing this condition from a fungating encephaloid cancer. The tumour is essentially benign in nature; it is never disseminated generally, and can be readily and completely removed, so that there is but little tendency to recur. In the early stages it is unnecessary to take away the entire breast if the tumour can be efficiently dealt with otherwise, but in the later stages the whole organ should be excised.

Somewhat similar in nature to the above is the condition known as a duct papilloma. This is characterized by the development of a soft

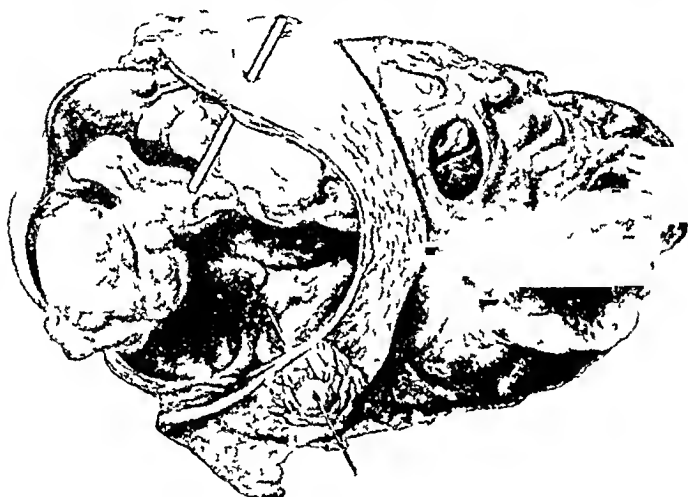


FIG 348 —CYSTO-ADENOMA MAMMÆ (MUSEUM OF ROYAL COLLEGE OF SURGEONS)

The fibro papillomatous growths are seen projecting from a large cyst, into which a bristle, passed down the nipple, enters. A glass rod has been passed through a perforation in the skin into the cyst.

polypoid papillomatous mass, generally of small size, in the interior of one of the terminal galactophorous ducts, which in consequence becomes dilated. A discharge of blood stained serum results, and there is usually but little tumour to be felt, although the nipple may be slightly pushed forwards and rendered prominent. It is often the precursor of a duct cancer. Amputation of the breast will in many cases be needed, but it may be feasible in some to deal with the tumour alone.

**Sarcoma of the Breast** is not a common disease (2 to 8 per cent of all mammary tumours). It originates in the connective tissue of the organ, being deeply placed in its substance, or perhaps more frequently developing in the outer and upper quadrant. It is of two chief types (a) The *round-celled* sarcoma forms a soft, somewhat elastic swelling, which grows rapidly, and although often limited at

first by a fibrous membrane, the capsule sooner or later gives way, allowing the growth to become diffused through the organ. It sometimes gives rise to secondary growths in the axillary glands, or becomes disseminated throughout the body by means of the blood-vessels. Cysts often occur in its substance, resulting either from hæmorrhage or occasionally from the dilatation of an incorporated glandular alveolus, in the latter case the cavity will be lined with epithelium. Myxomatous changes are also not unfrequently observed, and in the more rapidly growing recurrent tumours the mass is often a true myxo-sarcoma. It usually occurs in women between the ages of thirty and forty, i.e., somewhat earlier than scirrhus, whilst, its rapid growth and the absence of retraction of the nipple or dimpling of the skin are useful diagnostic features. Should pregnancy follow, the tumour may increase in size at an alarming rate. In the infiltrating forms it is almost impossible to distinguish it from encephaloid cancer, except on microscopic examination. (b) A *spindle-celled* sarcoma, or fibro sarcoma, is also met with, forming a rounded or oval tumour, more limited than the above, and growing somewhat less rapidly. It somewhat simulates an adenoma, but is more closely connected with the breast substance. The axillary glands are but rarely involved, and the sarcomatous nature is recognised by the microscope and by the great tendency of the growth to recur even after apparently complete removal, on account of this latter feature, the name of 'recurrent fibroid tumour' (Paget) was formerly applied to it. The recurrences generally take place at gradually diminishing intervals, and the tumour may then become softer and more vascular, occasionally the tendency to recur seems to wear itself out after the performance of several operations.

The **Treatment** of sarcoma mammæ consists in the removal of the entire organ at as early a date as possible, together with the axillary glands.

### Cancer of the Breast

No organ of the body, with the exception of the uterus, is more frequently the seat of cancer than the female breast, it also occurs in the male subject, but is about a hundred times less common than in the other sex.

**Ætiology**—The breast is an organ subject to great changes in functional activity, richly supplied with blood, and closely associated by nervous connections with other organs of the body, especially the uterus. At the climacteric its functions are at an end, and as it always undergoes a certain amount of fibrosis or degeneration, it can be readily understood that changes are very likely to ensue which may result in the formation of a cancerous tumour. Such is usually met with after the age of forty, although the disease may prove fatal at a much earlier date. It equally affects women who have borne children and nulliparæ, and the question whether or not the woman has nursed her children seems to have but little influence. The left breast is more often affected than the right. It is frequently attri-

buted to some injury, such as a blow or squeeze, whilst there is little doubt that badly-fitting stays are responsible for a certain percentage of the cases. It not uncommonly follows eczema of the nipple, especially that variety known as Paget's eczema, chronic interstitial mastitis may also possibly be an occasional precursor of this affection. The question as to heredity is one exceedingly difficult to decide, and, although it may be a marked feature of some cases, it is somewhat doubtful whether, as a general rule, it has any considerable influence.

Two distinct types of cancer are met with in the breast—viz, acinous or glandular cancer (including the acute form, and the more chronic type known as scirrhus) and duct cancer. Colloid degeneration of either of the former varieties has been observed, but is very uncommon.

1 **Acinous Cancer** includes the great majority of cases, the division into scirrhus and acute cancer depends clinically on the rate of growth, pathologically on the greater or less amount of fibrous stroma present in any particular case.

**Scirrhus** usually commences as a hard circumscribed mass, situated most commonly in the upper and outer quadrant of the organ. It is closely united to, if not absolutely incorporated with, the breast substance, and on careful digital examination its margin is not so accurately defined as at first appears. In the early stages it is entirely distinct from the skin, which moves freely over its surface, but as growth proceeds, the stroma contracts, and, by dragging on the suspensory ligaments of Cooper passing from the mamma to the skin, the latter structure becomes more or less fixed, and hence, on attempting to move it upon the tumour, an appearance of dimpling results. At the same time, the whole breast is acted upon in a similar manner, so that the affected organ sometimes seems to be smaller than the other, and, since the upper half of the gland is usually affected, the nipple may be drawn up so as to lie at a higher level than its fellow, as well as being retracted from the drag of the growth on the galactophorous ducts (Fig 349). The tumour itself is rarely one of great size, so long as it retains its scirrhous nature, it is sometimes extremely painful and tender, but not uncommonly the pain is intermittent, and of a neuralgic type, extending to the shoulder, and perhaps only elicited on manipulation. As the growth increases in size, it becomes adherent to the pectoral fascia, and may even infiltrate the underlying muscular substance, so that, on examination, with the arm extended and abducted, it is found that, although moveable across the fibres of the muscles, the breast cannot be moved with them.

The *lymphatic glands* in the axilla soon become enlarged, the disease rarely lasting many months without this complication. Those running with the long thoracic vessels under cover of the pectoralis major are first involved, and, as the case progresses, the remaining axillary and subscapular sets become similarly affected, and even after a time the supraclavicular. When the inner or deeper part

of the breast is attacked, the disease may spread to the mediastinal glands along the lymphatics, which accompany the nutrient vessels arising from the internal mammary trunk, and thus intrathoracic deposits develop, which even extend along the subpleural connective tissue, and affect the pleural cavity and lungs. In those cases where the primary growth is situated near the inner border of the breast, the free lymphatic anastomosis across the middle line allows of the transmission of the disease to the glands in the opposite axilla, and sometimes a similar affection of the opposite breast arises from this cause.

The *skin* may be implicated in many ways. (a) We have already mentioned the dimpling which is met with over the tumour in the

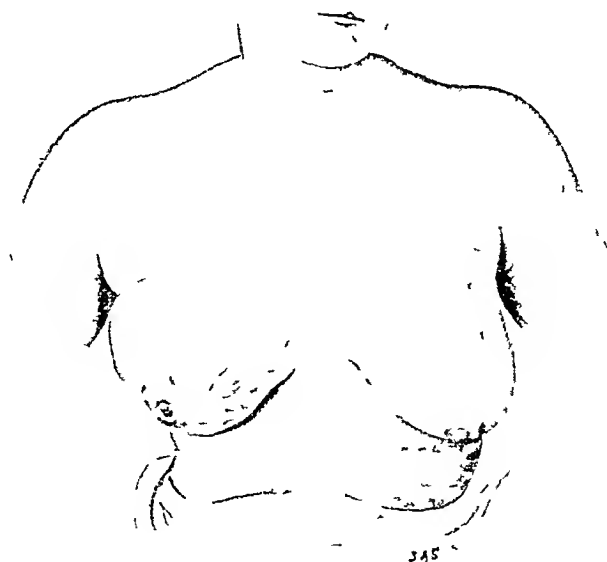


FIG. 349.—SCIRRHUS MAMMÆ (FROM A PHOTOGRAPH)

The patient had allowed the tumour to grow for two years. The whole of the right breast was infiltrated and raised above the level of the other organ; the nipple was retracted. Just above the nipple was a cancerous nodule in the skin and the *linæ albicantes* due to previous functional enlargement were hyperæmic and infiltrated.

**early stages** As the case proceeds, the cancer extends outwards along the suspensory bands of fascia, so that the skin itself becomes invaded, feeling firm and brawny, and looking congested and purplish in colour, whilst a branny desquamation is usually present. A crack or fissure at length forms, giving exit to a little serous discharge, which at first scabs over, but finally leaves an ulcerated surface, which slowly extends, and may attain considerable dimensions. A typical *scirrhous ulcer* is hollowed out and excavated, its surface, if kept clean, is covered with smooth granulations, discharging a con-

siderable amount of sanious fluid, but if neglected, it becomes sloughy and offensive, it is surrounded by a projecting elevation of the tumour substance, forming a sort of rampart around it (b) Less commonly the disease becomes disseminated through the skin, giving rise to a series of dusky-red, button-like masses of cancer, surrounded by skin which is often apparently unaffected, or the whole cutaneous surface of the organ may become infiltrated and thickened, constituting the condition known as cancer *en cuirasse*. In the earlier stages the skin is thickened and firmer than usual, but the mouths of the sebaceous glands are enlarged and very evident, giving it a coarse appearance like 'pig-skin,' or the rind of an orange (*peau d'orange* of French authors). Later the colour becomes dusky, and the skin so contracted and indurated that it is impossible to wrinkle it, the sebaceous glands may exude an abundant secretion, which becomes inspissated on the surface into crusts or scabs, which are independent of any ulceration. This process often extends widely beyond the limits of the breast, invading the whole thoracic wall, and even running over the shoulder to the back of the head or neck, it is due to a diffuse extension of the disease along the cutaneous lymphatics, and in its most typical form is slow in its development, the patient perhaps living for many years. Localized buttons or nodules of cancer are often found scattered through the affected area (c) Occasionally one meets with a much more rapid form of cancerous lymphangitis, in which the skin becomes similarly affected, but the growth is not unfrequently associated with what is supposed to be a 'weeping' eczema, due in reality to the yielding of dilated lymphatics, that can be easily seen on examining with a lens. The process spreads widely and rapidly, and cancerous nodules appear here and there in the infiltrated area, the prognosis is, of course, very grave.

In the later stages, the patient passes into a state of cachexia, becoming emaciated and exhausted. Ulcerated surfaces of considerable size may exist, and the tumour is fixed to the thoracic wall, even invading the ribs. The arm on the affected side is swollen and brawny, owing to the pressure of the enlarged glands on the main lymphatics and veins of the limb, constituting a condition of lymphatic or solid œdema. Secondary deposits also develop in the viscera, especially the pleura, lungs, and liver, and may lead to various symptoms. Not unfrequently recurrence takes place in the lymphatics of the connective tissue between the rib cartilages and the pleura, and these nodules of growth may project forwards through one of the intercostal spaces (usually the second). Deposits in the bones are also not unusual, the sternum, vertebræ, and femora being perhaps most often affected. Finally, death from exhaustion ends the scene.

**Acute Cancer** is fortunately not common, and appears as a somewhat soft, rapidly-growing tumour, which quickly infiltrates the whole organ, and gives rise to secondary lymphatic and visceral affections at a much earlier date than scirrhus. It does not cause retraction of the nipple or dimpling of the skin, the latter structure

being distended, and with blue veins coursing under it. The breast becomes enlarged and prominent, the skin is gradually invaded by the tumour, and if ulceration follows, a foul fungating mass sooner or later sprouts up through the opening. This variety usually attacks young women under thirty-five years of age, and runs a rapidly destructive course, especially if it occurs during pregnancy or lactation.

Finally, in elderly women, a chronic form of cancer is met with, known as **Atrophic Scurrhus** (Fig. 350), in which the disease lasts for many years without much definite extension. Cases have been known to persist for fifteen or twenty years, the patient at length dying of some intercurrent malady, although in the great majority

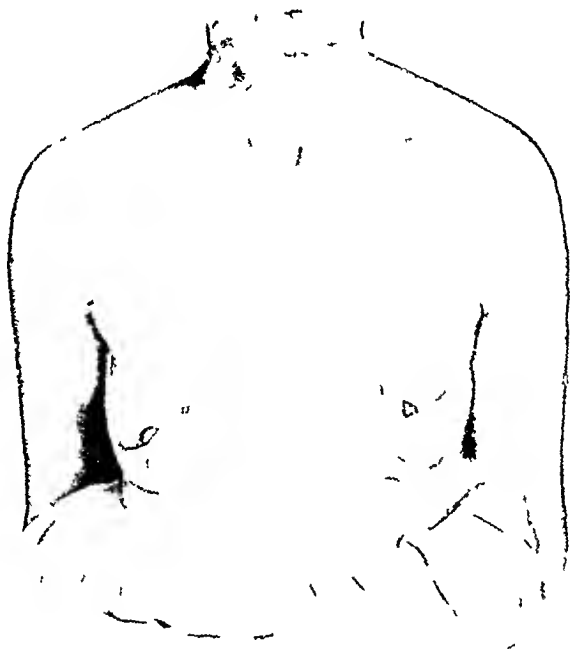


FIG. 350.—ATROPHIC CANCER OF BOTH BREASTS (FROM A PHOTOGRAPH)

The nipples are both retracted, and the skin around puckered and fixed to the growth. On the right side the axillary glands are obviously enlarged.

dissemination has ultimately occurred. The special characters are due to the excessive contraction of the stroma, as a result of which the cellular elements become crushed, and practically destroyed. The nipple is deeply retracted, and the tumour and breast substance in the most marked cases are scarcely discernible.

2 **Duct Cancer** is a somewhat rare form of the disease, the exact nature of which is still under discussion, and there is very little doubt that several distinct types have been described under this name. It is sometimes characterized by the development of one or more nodules

of a malignant papillomatous nature within the dilated ducts, and usually situated not far from the nipple. These growths are covered with columnar epithelium, and may, indeed, be looked upon as forms of columnar cancer. They are exceedingly vascular, and a blood-stained discharge from the nipple is usual. They always grow slowly, and when situated near the skin give rise to a round dusky-red swelling. The nipple is not retracted, and lymphatic enlargement not constant. In other cases the dilated alveoli are occupied by masses of proliferated epithelial cells of a spheroidal type, which arrange themselves into more or less definite papillomatous growths, whilst cystic degeneration also occurs. Either of these varieties may be associated with a development of ordinary scirrhus in some other part of the breast. The diagnosis can only be established with certainty by microscopic examination after removal.

**Adeno-carcinoma** is the term given by Halsted to a condition very similar to the latter variety of duct cancer. The growth consists of tubular spaces heavily lined with epithelium, it develops slowly, but frequently fungates through the skin, and presents as a localized pedunculated growth, which readily bleeds. The axillary glands are usually free from infection, and the prognosis is good.

The **duration** of cancer varies considerably in the different forms. The encephaloid type runs a rapid course, and will probably destroy the patient's life in six to twelve months. Duct cancer is very slightly malignant, whilst atrophic scirrhus is similarly slow in growth, and in both death may be postponed for a considerable period, or is often due to some intercurrent malady. Cancer *en cuirasse* is variable in its course, being sometimes tolerably rapid, and at others chronic, it cannot be cured by operation on account of its early and extensive dissemination. A circumscribed scirrhous tumour is stated to end fatally, on an average, in two or three years if no operative treatment is undertaken, whilst removal of the mass will probably add another year or eighteen months to the patient's life. These figures are, however, derived from statistics of operations performed before the general adoption of the more exact and extensive measures which are now usually undertaken, and it is likely that they considerably under-estimate the benefits derived from such interference.

The **Pathological Anatomy** of cancer is discussed at p 206.

The **Diagnosis** of scirrhus from *chronic interstitial mastitis* and *chronic abscess* or *cyst* has been already considered (p 941). From *tumours of the adenoid type* it is easily distinguished. The stony hardness of a scirrhus, its union with the breast substance, its limited mobility, the dimpling of the skin, retraction of the nipple, and enlargement of the axillary glands, are the chief local characteristics to be noted. Non-malignant tumours are more elastic to the touch, more moveable, and usually quite circumscribed in outline, whilst the skin, though expanded, does not become adherent, the nipple is rarely retracted, and the axillary glands remain of normal size. It is often impossible to distinguish a cancerous from a *sarcomatous tumour*, except on microscopic examination, a round-celled sarcoma closely resembles an

acute cancer, although it is usually more circumscribed—at any rate, in the early stages. A *fibro-sarcoma* may sometimes be mistaken for scirrhus, but it is more defined in outline, does not cause retraction of the nipple or dimpling of the skin, whilst lymphatic enlargement is not a constant accompaniment. A *cysto-adenoma* presents no difficulty in diagnosis if the skin is entire, and the cysts prominent, but when ulceration has taken place, and a fungating bleeding mass protrudes, it is not unlike the later stage of an encephaloid cancer or fungating round-celled sarcoma. It can be distinguished, however, by the fact that a probe can sometimes be passed under the skin for some distance into the cavity of the cyst, whilst lymphatic enlargement is rare.

**Treatment**—This necessarily consists in the removal of the tumour by operation in all cases where there seems a reasonable chance of eradicating the disease. The only conditions that would contraindicate operation are extensive adhesions to the thoracic walls, the presence of visceral deposits, and extensive diffusion of a rapidly-growing acute cancer in a young subject. Atrophic scirrhus is often left alone, on the plea that the prognosis is so favourable as to render operation unnecessary, if, however, the patient is fairly strong, there is no objection to it, and it certainly seems wise to remove a cancerous focus, however chronic it be. Disease of both breasts, although rendering the prognosis more grave, is, *ceteris paribus*, no hindrance, since both organs have been removed successfully, even at one operation. Speaking generally, rapidly-growing tumours in vigorous patients are very unfavourable cases to deal with, whilst slow growth of the tumour, and definite limitation of its outline, are favourable signs.

A full description of the operation is given below, but we desire here to emphasize the fact that the proceeding should be very radical if the patient is to derive any real benefit from it. In the old days, only the more prominent portion of the breast was removed with the tumour, and consequently recurrence was so extremely common that if 5 or 10 per cent of the patients were really cured, it was thought to be as much as any surgeon could reasonably expect. Since we have learnt more of the anatomy of the organ and of the pathogenesis of the disease (for which we are mainly indebted to Heidenham and Stiles), more extensive proceedings have been undertaken, with a gradual amelioration in the results, so that several surgeons have been able to report 50 to 60 per cent of their cases as free from recurrence at the end of three years. It was suggested by Volkmann that any case that remains free from recurrence for three years may be claimed as a cure, but this is generally considered too short a period on which to base such an assumption, since experience tells us that the disease often reappears at a much later date (even nine or ten years).

The breast has been demonstrated to be a much more extensive organ than was formerly supposed, its lobules extending upwards nearly as high as the clavicle, outwards into the axilla, and for some



distance downwards, so that removal merely of the prominent part of the gland may leave much behind, and thereby favour recurrence. Moreover, it has been shown that the deeper lymphatics pass into the fascia covering the pectoralis major, and so to the axilla, hence, this structure should always be taken away, as well as a thin layer of the muscular fibres, but the wiser course to adopt is to remove the whole of the sternal portion of the pectoralis major, leaving only the clavicular. Many surgeons also remove the pectoralis minor muscle, this procedure certainly favours the axillary dissection, and does not seem to have any harmful influence on the subsequent movements of the arm. Again, lymphatics travel along the fibrous bands reaching from the breast tissue to the overlying skin, and thus this latter must never be dissected back from over the tumour. The nipple should under no circumstances be left behind, since all the interlobular lymphatics converge to a plexus around it, and thence pass to the axilla by three or four main trunks. The axilla itself should be opened in every case, and entirely cleared of its lymphatic contents, since deposits in the glands are often found on microscopic examination, where no clinical evidence of their presence had been previously noted. It is also important to remove the breast and axillary tissues in one piece, so as to avoid division of the lymphatics and possible infection of the wound with their cancerous contents.

**Operation for Cancer**—The patient lies on the back, with the head directed towards the opposite side, and the arm raised to a little more than a right angle, so as to put the pectoralis on the stretch. An aseptic towel should be wrapped round the head, so as to keep the hair out of the way, and a similar sterilized towel may be placed below the chin, to form a barrier between the anæsthetist with his apparatus and the field of operation. The axilla should be previously shaved, and the skin carefully purified. The incisions employed vary with the size and position of the tumour, one great essential being that the whole of the projecting portion of the breast with its integumental covering should be removed, and that no part of the skin which lies immediately over the tumour should be dissected back and left. The primary object is to remove the growth together with the gland and all its ramifications, the question of being able to close the wound subsequently is quite a secondary and minor consideration. As a rule, sufficiently wide undercutting will allow even the most extensive wounds to be closed, but when this is impossible, skin-grafting at the time or subsequently can be adopted, and no lengthy convalescence need ensue. Figs 351 and 352 suggest the types of incision that may serve for the removal of tumours on the outer and inner sides of the breast respectively. Slight modifications will suggest themselves when the growth is in other positions.

When the incisions have been made, they are deepened, but not directly inwards. The skin around is dissected up so that the subcutaneous connective tissue may be removed together with the breast over a wide area extending as high as the clavicle above

down to the epigastric notch below, and behind the posterior border of the axilla on the outer side. The surface of the pectoralis major is then exposed throughout the whole length of the inner or upper incision, the connective tissue over it being turned downwards. The junction between the sternal and clavicular portions is defined, and opened up by finger and knife throughout its whole length. The insertion of the sternal portion is divided about an inch from the humerus, and then the finger is introduced under its origin from the sternum and costal cartilages, and this is severed by the knife close to the bone. Several perforating branches of the internal mammary will be divided in this procedure, and must be at once secured, so as to prevent their retraction through the intercostal spaces. The

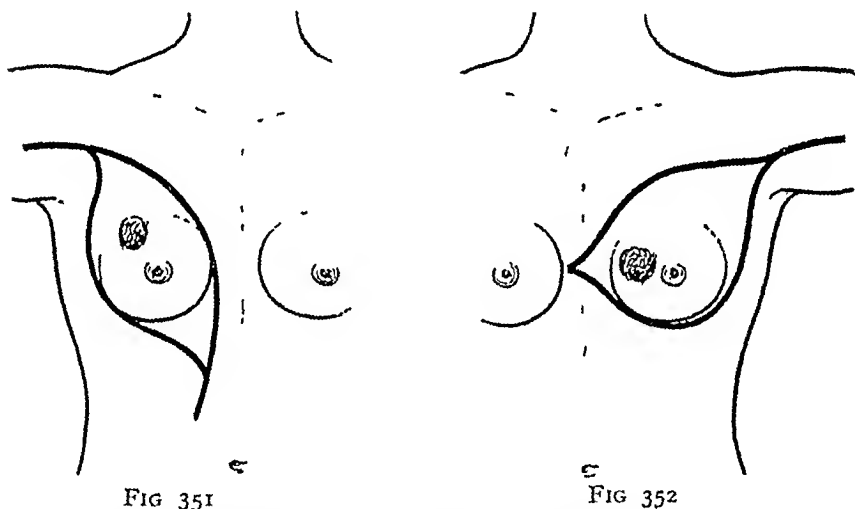


FIG 351

FIG 352

FIGS 351 AND 352 —INCISIONS FOR REMOVAL OF CANCEROUS BREAST WHEN THE TUMOUR IS SITUATED IN THE UPPER AND OUTER, OR IN THE INNER SEGMENT RESPECTIVELY

pectoralis minor now comes into view, and is divided at its costal attachments and also close to the coracoid process.

The breast and underlying tissues can now be drawn downwards and outwards, thereby opening up the axilla freely, the next step consists in thoroughly clearing it. The main vessels are first defined below the lower border of the pectoralis minor close to the outer angle of the wound, a layer of fascia needs division in order to accomplish this. The dissection is then carried inwards along the vessels and nerves, which are freed from fat and glands both in front and behind, if necessary. Arterial and venous branches are best secured by ligature before division. If the glands are closely adherent to the vein, it is wise to excise a portion of it rather than to attempt to peel them off. The most careful search for glands must be made in the apex of the axilla, and in removing them every effort must be used not to rupture the glands by careless handling, as thereby dissemination of cancer cells might occur.

The surgeon next proceeds to clear the fat and fascia from the serratus magnus on the inner side of the wound, care being taken to secure the lateral branches of the intercostal arteries as they are divided, and to protect the nerve of Bell. The subscapularis is then cleared, and possibly the subscapular vessels may need division, but the subscapular nerves must be spared. Not unfrequently there are many enlarged lymphatic glands in this part of the axilla. When this has been effected, but little more remains to be done except to free the breast, pectorals, and connective tissue from their external attachments, and this is quickly accomplished by a few sweeps of the knife.

An enormous wound results from this operation, and during the later stages the exposed tissues must be protected as far as possible by covering them with sterilized cloths. It may also be desirable to wash the wound over from time to time with hot sterilized salt solution. Bleeding points are now secured, and preparations made for closing the wound. Surrounding parts may need to be extensively undermined, or even plastic proceedings carried out in order to bring forwards redundant skin from the side and back. As a general rule the wound can be more or less completely closed by the exercise of a little patience and ingenuity. Should it have to be left open, it is probably wise to defer a grafting operation till later. Deep tension stitches are often useful, and the margins of the wound are approximated by ordinary catgut or silk sutures. Drainage is usually desirable, and the tube may be placed through an opening made for it in the posterior axillary wall. A large and efficient dressing is applied back and front to receive the sero-sanguineous discharge, which is sure to be abundant. The arm is left at right angles to the side throughout the healing with the object of preventing the subsequent stiffness and limitation of movement, which was so marked formerly when the arm was bandaged to the side. The first dressing will be required in thirty-six or forty-eight hours, and the drainage-tube may then be removed. Healing should be complete in from ten to twelve days.

The immediate results of this operation are exceedingly satisfactory, the mortality being under 5 per cent. The ultimate results necessarily vary with the period at which the operation was undertaken, with the extent and character of the disease, and with the thoroughness and skill of the operator.

In a few early cases a somewhat less severe operation may be justifiable, the modification consisting in the non-removal of the pectoral muscles. The whole of the breast and of the skin over it must, however, be taken away, as well as the fascia over the pectoral muscle, and the axilla must be thoroughly cleared.

When the supraclavicular glands are enlarged, the operation must also include the supraclavicular fossa in its scope, as recommended by Halsted, he, indeed, goes so far as to maintain that the posterior triangle should be cleared of its lymphatic contents in all cases, whether or not enlarged glands can be detected beforehand, and states that in a

considerable percentage cancerous invasion will have already occurred. The cervical incision is a curved one, extending along the posterior border of the sterno-mastoid, and outwards along the clavicle. This flap is dissected up, and all the fat and glands are removed from before backwards, the internal jugular vein being the starting-point. Of course, the greatest care is taken to avoid the thoracic duct or right lymphatic trunk. Some surgeons go so far as to divide the clavicle, but this seems to be a needless proceeding. The axillary and the supraclavicular wounds can easily be made continuous under the clavicle. In the majority of cases, however, the cervical operation will probably be secondary, and undertaken for recurrence.

*Local recurrence after operation* is always due to incomplete removal of the growth, or to infection of the wound during the operation. The operator must ever keep in mind that although in a healthy organism the implantation of cancerous material has apparently but little or no effect, yet in a cancerous individual positive results are only too certainly obtained. The recurrence appears either in the neighbourhood of the cicatrix, the most usual situation, or in adjacent lymphatic glands, in the other breast, or in the retrocostal connective tissue. The progress is often slow, but occasionally the disease spreads more rapidly than if no operation had been undertaken. Another attempt should always be made to remove the growth, if such be feasible.

Diffuse cancer of the skin (*en cuirasse*) is not suitable for operative treatment, but much may be done by exposure to the X rays (p. 210) or by radium.

Some years back Beatson of Glasgow proposed to treat inoperable cases by double oophorectomy and the administration of thyroid extract. Many patients have been dealt with in this way, and the results gained thus far show that a few cases have been apparently cured, in a much larger number no effect was produced, but that in quite an appreciable proportion the disease seems to have been temporarily controlled (perhaps for years), and the pain and discomfort very definitely diminished. Probably the thyroid extract does no good, and the results are to be ascribed to the oophorectomy. The operation should only be undertaken in women who have not yet reached the climacteric, but if they fully understand what it involves, we consider it justifiable. We have certainly seen it followed by retrogression of growths and diminution or cessation of pain, which are not usual in the course of an inoperable recurrent scirrhus.

**Amputation of the Breast** for *non-malignant* conditions is a very different operation to that described above. The incisions usually employed are crescentic and placed obliquely, they need not include much more skin than that indicated by the breadth of the areola. The integument is dissected up from the glandular tissue on either side, and the organ freed from its attachments to the pectoral fascia, the axilla is frequently not opened.

## CHAPTER XXXIV

### ABDOMINAL SURGERY

**General Remarks on Abdominal Operations** — Formerly these were of rare occurrence, and perhaps this was as well, since septic peritonitis frequently followed. At the present time no competent operator hesitates to open the abdomen whenever required, and the death-rate from preventable causes has been steadily diminishing. The peritoneum, which formerly the surgeon dreaded to touch, is now one of his best friends, if properly treated. Attention to minute details is essential if good results are to be obtained, and the following are a few points which may prove of service to those aspiring to success in this important branch of work.

The patient should be carefully *prepared*, when circumstances permit, by regulating the diet and bowels for some days previously, so that the intestinal canal may be as free from organisms as possible, a course of internal antiseptics, such as salol, calomel, or  $\beta$ -naphthol, may be advisable. The abdominal wall is shaved, as also the p $\ddot{u}$ bes and vulva, and thoroughly purified beforehand in the usual way. Especial care is directed to the umbilicus, where dirt is very liable to lodge. On the night previously an effective purgative is given, *e g*, 1 ounce of castor oil, and an enema may be desirable in the morning to ensure that the lower gut is empty.

No food should be allowed by mouth for some hours, and immediately before being placed on the table the bladder should be emptied. If the proceedings are likely to be protracted, it is advisable to give a rectal injection of warm saline solution, or of beef-tea and brandy, half an hour beforehand, and possibly a hypodermic injection of strychnine (gr  $\frac{1}{100}$ ).

The patient should be warmly wrapped up and protected from cold, no unnecessary exposure being allowed. Full anæsthesia is desirable, so as to diminish shock. Intraperitoneal operations are not painless, for although the visceral peritoneum is not acutely sensitive, yet the parietal layer is, as well as that included in the mesenteries, and any handling of these structures gives rise to pain and necessarily to increased shock, if the patient is conscious.

As a general rule the patient is lying flat on the table, but if the operation involves the pelvic viscera, the *Trendelenburg position* is

advisably adopted. In it the patient is placed with the head considerably below the rest of the body, which is more or less inverted (Fig 353). The knees are bent over the end of the table, and help to keep the body in position. The headpiece of the table must be lowered, or the neck will be bent forwards into a position that much impedes respiration. The arms must not be kept above the head, or musculo-spiral paralysis may follow, they are best placed behind the patient's back. This position must never be adopted in conditions where obstruction is present, and the stomach is likely to be filled with offensive material which might gravitate into the mouth and suffocate the patient.

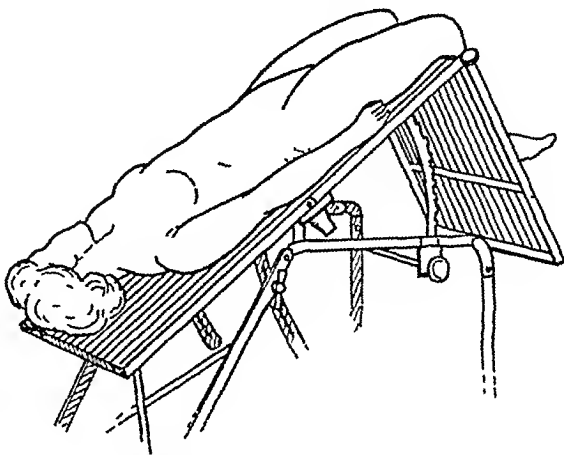


FIG 353 —TRENDLENBURG'S POSITION FOR PELVIC OPERATIONS

Antiseptics should be avoided as far as possible in intraperitoneal operations, after efficient sterilization of the hands of the surgeon and his assistants and of the skin of the patient, nothing is employed in the shape of lotion except sterilized salt solution. Instruments are boiled previously and counted. Sponges are carefully purified beforehand, and wrung out in salt solution, they are counted before and after operation. Swabs are best done up in packets of a dozen, wrapped up in gauze, it is thus easy to keep account of the number employed. Gauze strips for packing, abdominal cloths, etc., are dealt with in the same way, and the assistant and nurses must make a careful mental record of the number employed. If any irrigation of the abdomen is required, warm salt solution is the best lotion to use for the purpose.

**Parietal Incision** —Formerly, whenever practicable, the incision was made in the middle line through the linea alba, in consequence of the facts that there is less bleeding in this situation, that all parts of the abdomen are easily accessible from it, and that the wound is more rapidly closed. It has been found, however, that ventral hernia is a not uncommon sequela, and hence, although the median incision is still largely retained on account of its convenience, and especially in septic cases that need to be drained, it has been discarded in many situations, and incisions have been planned going through more vascular structures. Even in such operations as ovariectomy, where the middle line gives the best access, it is wise to go through the rectus a little to one side of the centre rather than through the linea

alba itself The linea semilunaris, again, is a bad situation for an incision, since the traction of the muscles which are inserted into its outer side is so great that hernia is very likely to follow On the other hand, care must be exercised not to place the incisions too near the bony margins of the abdominal cavity, or subsequent manipulations may be hampered by the rigidity of one side of the wound

The muscles should be cleanly divided, and it is wise to see that all bleeding is stopped before opening the peritoneum Directors are best avoided, since they are very likely to wound the serous membrane, and are quite unnecessary in skilled hands A small hole should be first made in the peritoneum, through which a blunt-nosed pair of forceps is inserted, and by lifting these up and allowing the blades to separate slightly, a convenient and safe substitute for a director is obtained If a long incision is needed, the left index and middle fingers are passed through this opening, the intestines and omentum are thus kept out of the way, the peritoneum being well raised and divided by scissors to the required extent

Several ingenious methods of opening the abdomen have been suggested of recent years, with the idea of minimizing the chances of subsequent ventral hernia It must ever be remembered that the method of opening the abdomen is every whit as important as that of closing the incision, above all, it is desirable that the motor nerves of the abdominal parietes should be respected *McBurney's muscle-splitting* method is largely adopted in removing a quiescent appendix (p 1042), it gives a sufficient approach when there are no adhesions, and the appendix is not displaced, but should these conditions not be present, or if the patient is very stout, it will prove most inconvenient It may also be used in iliac colotomy *Lennander's trap-door* incision consists in opening the sheath of the rectus in front, displacing the muscle in or out, and then making the incision in the posterior layer of the sheath and through the peritoneum so as not to correspond too closely to that in front The replacement of the rectus constitutes an extra barrier to the prevention of hernia

- The intestines must be most carefully guarded during the intra-peritoneal portion of the operation, as if they are unduly exposed to the air, the endothelial lining is quickly shed, and adhesions may form from without, whilst bacterial invasion may be predisposed to from within If they have to be withdrawn from the abdomen, they must be wrapped up in cloths wrung out of warm salt solution, and it is the assistant's duty either to replace these from time to time by warm cloths, or to keep them moist and warm by pouring fresh salt solution over them, no unnecessary handling of intestine is permitted If any infective focus is to be opened, or the intestine incised, the surrounding parts must be carefully protected from infection by 'walling off' the area of operation, this is effected by introducing boiled abdominal cloths (made of soft calico, and about 16 inches square) or strips of white sterilized gauze wrung out of warm salt solution all round the wound, especially in directions where pus or

other fluids might gravitate. A careful record of these must be kept, and it is wise not to cut any of them into smaller pieces.

**Closure of the Wound**—A careful toilette of the peritoneum must be undertaken before the abdomen is closed. All bleeding is stopped and blood-clot removed, sponges are counted, and, if there has been any extravasation of infective material, it is well to wash the site of operation with sterilized salt solution at a temperature of about 108° F, a proceeding which often assists considerably in minimizing shock. Many different methods of closing the parietal incision have been adopted, but perhaps the best consists in firstly securing the peritoneum by a continuous catgut stitch, then the muscular coats are approximated by deep interrupted stitches either of purified silk or of silkworm gut, which remain buried, and finally the skin is united by means of a continuous suture, which is subsequently removed.

**Drainage** is not usually called for in abdominal operations. If the surgeon is careful in his manipulations, and avoids measures which are likely to lead to subsequent oozing, the peritoneum may be closed with safety. Where an inflammatory focus has been opened, or when adhesions likely to bleed have been divided, or raw surfaces left such as occur after enucleating a parovarian cyst from the broad ligament, some means should be provided whereby any considerable effusion of fluid can escape. It is found that capillary-drainage along a strip of gauze is the best that can be employed for blood or serum. Ordinary indiarubber tubes are liable to become blocked by portions of the intestine protruding into the lateral openings, whilst glass tubes, such as Keith's, are unyielding, and fail to accommodate themselves to the sinuosities of the regions needing drainage. Strips of aseptic gauze are therefore inserted like lampwicks, and along these, by capillary action, the effusion finds its way into the general dressing placed over the wound. Of course a certain amount of adhesive inflammation follows, and therefore the wick should be as small as possible, consistent with efficiency, and is changed or removed at the end of forty-eight hours. In some cases it is an advantage to enclose the gauze-wick in gutta-percha tissue which has been previously perforated here and there. Where, however, pus is to be removed, an ordinary drainage tube must be employed.

**After-Treatment**—After the completion of the operation, the patient is replaced in bed, with the head low. If restless and irritable, a small dose of morphia may be administered, but the less, the better, since it induces intestinal paresis, and this in turn assists bacterial invasion from the gut. No food is allowed to enter the stomach for twenty-four hours, although the mouth may be washed out with warm water or with still lemonade, and nutrient enemata administered every four or six hours. The great essential is to avoid vomiting, and this is best accomplished by a complete temporary cessation of stomach-feeding. At the end of twenty four hours, if all is going well, a little fluid nourishment is given, and this is gradually increased. Of course, special directions as to feeding



are required when the stomach itself has been incised. The bowels may be opened by castor oil on the third day unless there is any special necessity for keeping them quiet for a longer period.

Not uncommonly there is a good deal of discomfort and abdominal distension for the first few days. This is usually due to a collection of flatus which the patient is unable to pass. The introduction of a flatus tube may succeed in giving relief, failing this, a turpentine enema may be administered. If peritonitis is threatening, the patient complains of abdominal pain and distension, whilst flatulence and vomiting are distressing symptoms (*peritonism*). Under these circumstances the administration of a saline purgative (e.g., 20 grains of sulphate of soda every half-hour) may stop the process by re-establishing peristalsis, removing bacteria and their products, and lessening the vascular tension. Should these measures fail, the outlook is grave, in some cases it may be justifiable to reopen the abdomen, wash out, and drain.

*Stitch suppuration* is a troublesome and irritating sequela of abdominal operations. It may be due to faulty technique, but occurs quite apart from this. The most careful sterilization of suture material will not always prevent its occurrence, and then it must be attributed either to tying the suture too tightly and strangling the tissue within its grasp, to auto-infection of this strangled tissue, or of some collection of blood around it. The trouble may start early or late, and its occurrence is not unfrequently indicated by a slight but persistent rise of temperature (say, to  $100^{\circ}$  every night). The external wound may apparently heal perfectly, and then ten or twelve days after the operation the cicatrix yields, and a quantity of pus may escape. Under these circumstances efficient drainage should be arranged, and if need be the exposed stitches must be removed. Of course, this process weakens the abdominal wall, and extra precautions must be taken to prevent the formation of a ventral hernia.

**Intestinal Sutures**—The interior of the bowel is occupied by material which, as long as it remains in its proper place, is innocuous enough, but should it find its way into the peritoneal cavity, an acute and often fatal peritonitis is almost certain to follow. Hence, every union made by the surgeon must be air- and water-tight, and capable of accommodating itself to varying degrees of intra-intestinal pressure. For this reason a continuous stitch is seldom employed except in the long axis of the bowel, or when there is some button or bobbin within it. Again, it is essential that on its peritoneal aspect the line of union should present nothing but serous membrane, as otherwise adhesions are certain to form, and the comfortable action of the bowel will be subsequently impaired. Hence, special forms of stitches have to be adopted, the more important of which are described below.

*Lembert's Suture*, originally proposed at the end of the eighteenth century, has for its object the bringing of surfaces of peritoneum together without encroaching on the mucous membrane, any stitch which involves the whole thickness of the wall is liable to be followed

by leakage of the intestinal contents, and possibly by peritonitis. The needle is passed at right angles to the axis of the wound through a small fold of the serous and muscular coats, going down to the sub-mucosa, each fold is placed about  $\frac{1}{16}$  inch from the margins of the incision (Fig 354). On drawing up and tightening the stitch, the margins of the wound are tucked in (Fig 355), and only the serous

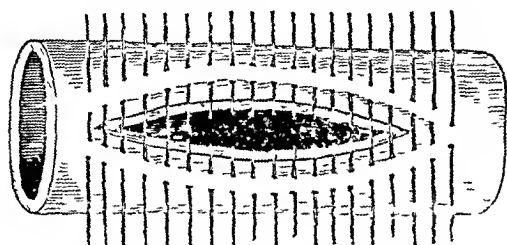


FIG 354 — LEMBERT'S SUTURE AS APPLIED FOR A LONGITUDINAL WOUND OF THE BOWEL

The stitches are carried well beyond the extremities of the incision, so as to obliterate the groove always caused by this method of suturing

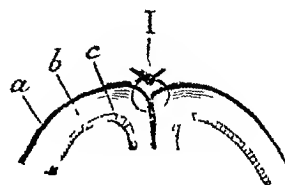


FIG 355 — LEMBERT'S SUTURE SEEN IN SECTION, TO SHOW CHARACTER OF APPROXIMATION

I, Suture, a, serosa b, muscularis, c, mucosa

coats brought into apposition. A series of similar stitches are inserted along the whole extent of the wound, numbering about ten or twelve to the inch, or it may be carried on as a continuous stitch. In closing a longitudinal incision in this way, a groove will be formed at either end which must be obliterated by two or three extra sutures. For a small puncture the same type of stitch is utilized, but it may be introduced circularly around the opening like a purse-

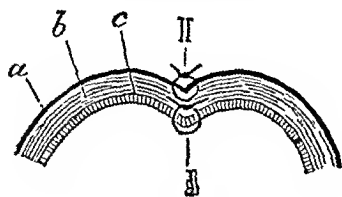


FIG 356 — CZERNY LEMBERT SUTURE

I, Stitch securing divided mucous membrane II, ordinary Lembert suture for the serous coats, a, serosa, b, muscularis c, mucosa

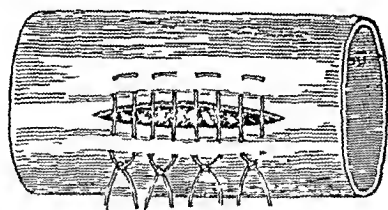


FIG 357 — HALSTED'S MATTRESS SUTURE

string, and by tightening it the margins of the aperture are turned in and buried.

The *Czerny-Lembert Suture* is very similar in its nature, but consists of two rows the first has for its object the closure of the wound in the mucous membrane (Fig 356, I), and in a longitudinal wound this may be of the continuous type, the second row consists of the ordinary Lembert stitches, continued or interrupted according to the requirements of the case (Fig 356, II). By this means the

knots of the first series of sutures are covered over and buried by the second row

*Halsted's Mattress Suture* (Fig 357) is a very valuable one, and constantly utilized. It consists practically of a double Lembert, a loop being thus formed at one end, whilst the knot is tied at the other. It is introduced with exactly the same precautions as the original Lembert.

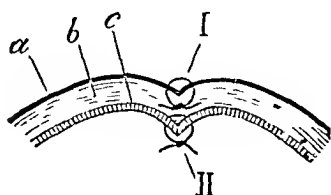


FIG 358 —WOLFLER'S SUTURE

I, Stitch through serous and muscular coat applied and tied from within. II, stitch uniting divided mucous membrane over the former, so as to cover it in. *a*, serosa, *b*, muscularis, *c*, mucosa.

Occasionally it happens that two segments of bowel have to be stitched together from inside, since the surgeon cannot reach the outer coats owing to this portion being fixed. Thus, in an exploratory gastrotomy it may be necessary to stitch up the posterior wall of the stomach after having opened it from the front. The stitches must then be inserted by what is known as

*Wolfler's Method* (Fig 358). They are

first passed through the serous and muscular coats on either side (I), the knots being tied on the inner aspect—*i.e.*, towards the lumen of the open gut. The mucous membrane is then secured by a second row of stitches (II), so as to cover over the first series of knots. In some cases of intestinal anastomosis this plan has also to be employed, as soon as possible, however, one changes to the Czerny-Lembert method.

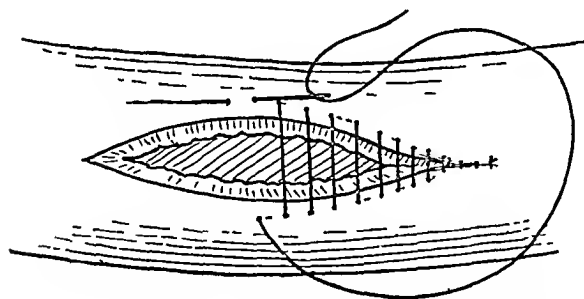


FIG 359 —CUSHING'S RIGHT ANGLED SUTURE FOR UNITING THE SERO-MUSCULAR COATS OF THE STOMACH OR INTESTINE

*Cushing's Right-angled Suture* (Fig 359) is a most useful one when surfaces of some extent have to be approximated by a continuous stitch. The suture is introduced at one end of the incision and tied according

to the usual Lembert method, and then it is carried on as a continuous Lembert suture, except that the needle is introduced *parallel* to the margins of the wound and at a distance of about  $\frac{1}{8}$  inch from it, instead of at right angles to it. The edges are thereby tucked in very neatly. Of course the mucous membrane is first dealt with separately by some form of continuous suture. It may be employed very advantageously in gastro-enterostomy or any similar procedure.

## Injuries of the Abdominal Wall

These may be divided into three main classes—contusions, non-penetrating and penetrating wounds, but, of course, the most important point about them is as to whether or not visceral complications are present

**Simple Contusions** of the abdominal parietes differ but little from those of any other region of the body. Any form of lesion, from a slight bruise to an extensive muscular laceration, may be included in this category. The rectus is the muscle most often involved, and its laceration may result not only from injury, but also as a consequence of sudden and forcible contractions, *e g*, in tetanus. Blood is extravasated between or under the muscles, and a well-marked hæmatoma may follow. In connection with the rectus the hæmorrhage may be limited by the lineæ transversæ if it only involves the anterior aspect, but may diffuse itself widely through the sheath if the back of the muscle is torn. All abdominal hæmatomata are very liable to suppurate, the abscess either pointing locally or burrowing widely between the muscular planes, and coming to the surface at some weak spot, *e g*, Petit's triangle or the external abdominal ring. The pus is usually redolent of the *B coli*, suggesting that the organism found its way into the extravasated blood from some damaged coil of intestine in the neighbourhood. Occasionally the parietal peritoneum is torn, causing shock and intraperitoneal extravasation of blood. In almost all cases of abdominal contusion<sup>1</sup> shock is a marked symptom, but in the absence of visceral lesions it, is neither severe nor prolonged

**Treatment** consists in keeping the patient in bed until the tenderness and pain have disappeared. Shock is dealt with in the usual way, and fomentations or a firm compress of dry hot wool will give much comforting support. Rupture of the rectus muscles necessitates the adoption of the sitting position, with the knees flexed over pillows, at a later date support, as by strapping or a well-fitting abdominal belt, will be required

**Non-Penetrating Wounds of the Abdominal Wall** have no special significance, and if uncomplicated by visceral lesions are treated on general principles. If the epigastric artery is divided, extensive extravasation is likely to ensue, the wound must then be enlarged, and the bleeding points secured. If the abdominal muscles are widely divided, steps should be taken, after thorough purification, to draw together the severed muscular or aponeurotic fibres by deep stitches, so as to diminish the tendency to a ventral hernia

**Penetrating Wounds of the Abdominal Wall** may occur with or without injury or protrusion of the abdominal viscera. In all cases there is a certain amount of hæmorrhage, greater or less according to the size of the vessels divided, and of shock, which latter is very marked when the viscera are injured, whilst mere protrusion without injury may cause but little effect. Thus, cases are on record in which a patient has walked to the surgeon for treatment, supporting

some coils of intestine in his hands. The protruded viscera, usually small intestine or omentum, are often large in amount compared with the size of the opening, causing them to be more or less congested, or even strangled. Necessarily, in all cases the great danger is that of diffuse septic peritonitis, caused either by rupture of the intestine or by infection from without. We have already alluded to the fact that the peritoneum which covers the viscera has but little sensation of pain, whilst the parietal peritoneum and that forming the mesentery are very sensitive, on the other hand, the visceral peritoneum is much more liable to bacillary invasion.

**Treatment**—The external wound is carefully cleansed, whilst protruding viscera are similarly purified. If omentum has escaped, it is wise to ligature and remove it, whether it is injured or not. Intestine should be carefully washed with warm saline solution, or with weak antiseptic lotions, such as boric acid lotion or sublimate (1 in 4,000), and then replaced; if slightly bruised, it may be returned, but the external wound should not be entirely closed and a drainage wick of gauze is inserted, so that if bacillary invasion or fæcal extravasation occurs subsequently, a ready exit is provided. Small incisions or punctures must be sutured, but when small intestine is seriously damaged, enterectomy should be undertaken if the patient's general condition is sufficiently good, otherwise it must be fixed to the abdominal wall, and a temporary artificial anus provided. With the large intestine, this latter course is required more often, and especially in cases where the bowel is loaded with fæces, the gut must then be fixed in the wound as in colostomy, and the defect dealt with at a subsequent period.

In cases where it is not certain whether the peritoneum has been implicated, the surgeon should always enlarge the wound so as to make sure, and if the serous membrane has been involved, he should carry his investigations still further, and ascertain, if possible, whether any damage had been done to the viscera.

The external wound must (with the exception mentioned above) be carefully closed with sutures, so as to minimize the risk of a subsequent ventral hernia. The peritoneum and divided muscles are united by buried stitches of catgut or well-boiled silk, and finally the skin is brought together with a continuous suture. A drain-tube may need to be inserted for a time.

**Visceral Complications** are likely to be associated with any injury to the abdominal wall, and may transform it into a lesion of the gravest import. The liability to visceral injury varies with the character of the violence, and with the condition of the abdominal wall and of the subjacent viscera. If the blow is slight, the effects are probably not serious, and the patient merely suffers from a localized contusion with some amount of shock. If the blow is expected, and the muscles are rigid, but little harm may follow, even when the violence is great, but when the abdominal wall is relaxed and the blow unexpected, a slight injury may do much mischief. Hollow viscera, such as the stomach, intestine, or bladder, may be torn,

and when distended they are more liable to such an accident. Solid viscera, such as the liver, spleen, or kidneys, may be bruised or torn, and grave hæmorrhage may result therefrom, a soft fatty condition of the organs, especially of the liver, may predispose to such a lesion. Displacement of organs may sometimes occur, and it must not be forgotten that any sudden sharp concussion, especially if directed to the epigastrium, is liable to be followed by severe shock from irritation of the subjacent solar plexus of the sympathetic nerves, and life itself may be destroyed in this way by syncope without the appearance of an evident lesion.

The clinical history of these injuries will be described under the various organs, and only a few general statements need be made here. It is obvious that a serious responsibility rests upon the medical attendant in any case of abdominal injury, and that the gravest results may follow a mistaken conclusion as to the nature of the lesion, or a hesitant policy in undertaking operation. In a large proportion of cases abdominal injuries, even including rupture of intestine, are amenable to operative treatment, if only it is performed sufficiently early, if, however, operation is delayed until the gut is paralyzed and peritonitis well established, death is almost certain to ensue whether operation is undertaken or not. Unfortunately, no absolute rules can be laid down as to when operation is necessary, but the surgeon should remember that exploration in a doubtful case will probably do far less harm than delaying operation until the diagnosis is made certain by an outbreak of diffuse inflammation, providing always that the patient is not so profoundly collapsed as to contra-indicate all interference.

Cases of serious abdominal injury group themselves into three sets: (1) Where, in addition to a localized lesion of the parietes, there is severe shock due to contusion of viscera, but with no justification for laparotomy, (2) where there is serious intraperitoneal hæmorrhage, as from a ruptured liver or spleen, or a tear of the mesentery, and (3) where a hollow viscus is opened, and peritonitis is at once lighted up.

*Shock* is almost always well marked in abdominal lesions, but unless there is a serious wound of some viscus, it usually passes off in less than twenty-four hours if the patient is left quietly in bed. *Intraperitoneal hæmorrhage* causes various symptoms according to its amount and site of origin, in addition to the initial shock, the general signs characteristic of this condition show themselves, viz, pallor, restlessness, 'air-hunger,' and possibly the large-waved hæmorrhagic pulse. Dulness may be noted in one or both flanks, according to the situation of the lesion, being influenced by the attachment of the mesentery, thus blood from the liver may gravitate into and for a time be limited to the right lumbar region and iliac fossa without reaching the pelvic cavity, blood from the spleen will pass freely down into the pelvis along the left side of the mesentery, producing dulness in the left loin and not in the right. When the bleeding is less severe, the patient complains of a severe

tearing pain, becomes pallid and anæmic, but may recover, and the blood be absorbed, not unfrequently the temperature runs up after the initial shock has passed, and remains up for some days, possibly from absorption of fibrin ferment. The onset of *peritonitis* is indicated by persistence of the collapse, and the onset of vomiting or hiccough, whilst the abdomen becomes distended, its wall is held rigidly steady, and the breathing becomes thoracic, probably some fixed spot of maximum tenderness will be noted, especially when the intestine is injured.

**Treatment** —The patient having been put to bed, and the initial shock combated in the usual way, a most careful examination of the patient and his abdomen is instituted. Facts which indicate immediate operation are (a) well-marked intraperitoneal hæmorrhage, (b) blood-stained vomiting, indicating a rupture of the stomach, and (c) the phenomena due to a ruptured bladder. Under such circumstances, no delay is justifiable, and, even if severe shock is present, operation should be commenced, unless death is evidently imminent. A large intravenous injection of hot saline solution will usually rally the patient sufficiently to warrant the surgeon in proceeding, whilst freely washing out the peritoneal cavity with the same hot solution has often a similar effect. If, however, well-marked shock is present, with perhaps localized pain, but with no absolute evidence of visceral lesions, expectant treatment should be adopted. The patient is kept warm in bed, perhaps a little opium is administered to allay pain and restlessness and to check peristalsis, but as little as possible should be given, since symptoms are so completely masked thereby. If there is any vomiting, rectal alimentation should be employed after the lower bowel has been washed out. If the manifestations of intraperitoneal hæmorrhage subsequently make themselves evident, or if at the end of not more than twenty-four hours the patient is still, more or less, in a condition of collapse, and especially if he complains of a fixed tender spot with a rigidly contracted abdominal wall over it, or if vomiting or hiccough has supervened, then operation can still be undertaken with some prospect of success.

There are but few other conditions of the abdominal wall which require notice. The rectus muscle may be torn as a result of injury or tetanic convulsions, and a hernia is very likely to follow. One of the segments may become spasmodically contracted, constituting what is known as a 'phantom tumour,' usually occurring in hysterical females, and disappearing under an anæsthetic.

### Affections of the Umbilicus

The various forms of umbilical hernia are described at p 1083

**Inflammation and Ulceration**, perhaps running on to eczema, may arise from want of cleanliness after separation of the cord. Tetanus neonatorum probably owes its infection to this source, as also the erysipelas of infants, both of which diseases are exceedingly fatal, whilst the latter is often accompanied by sloughing of the neighbour-

ing abdominal parietes The eczematous condition merely requires cleanliness, and the application either of an antiseptic dusting-powder or of some simple ointment

Occasionally a **Polypoid Excrescence** is met with growing from the umbilicus, and is probably derived from the remains of the umbilical vesicle On microscopic examination, it is found to consist of a number of tubular glands held together by connective tissue All that is required is to ligature the base and cut it away

**Warts** and **Nævi** are also found here, but need no special notice, as also syphilitic and cancerous disease The latter is either an epithelioma, starting in the skin as a result of prolonged irritation, or a columnar carcinoma, which may arise primarily in some foetal relic or be secondary to an intra-abdominal focus

**Umbilical Fistulæ** not unfrequently occur, and may be congenital or acquired Three varieties are described

(a) A *Fæcal Fistula* of congenital origin arises from non-closure of the vitello-intestinal duct, and either opens into the intestine directly, or by means of a passage of greater or less length, which corresponds to Meckel's diverticulum, and is connected with the lower part of the ileum Sometimes this passage is closed at the intestinal end, and then only discharges mucus Acquired cases are usually due to perforation of the bowel following strangulation of an umbilical hernia, or to tuberculous peritonitis

(b) A *Congenital Urinary Fistula* is due to non-closure of the urachus, occasionally merely a sinus persists, leading towards the bladder, but not opening into it It may be dealt with by excision of the mucous membrane, its destruction by the galvano-cautery, or by freshening the edges and subsequent suture

(c) A *Biliary Fistula* sometimes forms at the umbilicus, resulting from an abscess connected with the gall-bladder

In **Ectopia Vesicæ** the umbilicus is absent, the extroverted portion of the bladder extending up to what should normally be its situation

### Affections of the Peritoneum

**Peritonitis** arises from many different conditions, and presents many different manifestations It may be acute or chronic in its course, localized or diffuse in its distribution, and protective or rapidly destructive in its results

**Ætiology**—Peritonitis is almost invariably due to the action of micro-organisms, and the symptoms largely depend on the toxæmia determined thereby The bacteria light up an inflammatory reaction characterized by effusion of varying type, in the mildest forms it is usually abundant and localized, in the severer types it is generalized, and in the worst cases death may ensue from toxæmia before there has been time for the development of marked anatomical changes

1 Infection may start from any part of the intestinal canal or its adnexa included in the abdomen, from stomach to rectum It may be due to traumatic or pathological rupture or perforation, to the



extension outwards of ulcers, to the impaction of foreign bodies, or the damaging influence of interference with the blood-supply, as in strangulation, volvulus, etc. The vermiform appendix is the commonest site of onset of this group of cases. The *Streptococcus pyogenes* and *B. coli* are the organisms most frequently present, but some of the other inhabitants of the intestine, especially those that are anaerobic, are occasionally causative. On the whole the gastric contents are less noxious than those of the intestine, and the fluid contents of the small gut are more liable to be diffused, and therefore do more harm than the more solid faeces in the large

2 A somewhat similar type of origin causes *pneumococcal-peritonitis*, the organisms (usually streptococci, but of any pyogenic form) extending from the uterus through the lymphatics of the broad ligament, etc., to the peritoneum, it is therefore possible for the mischief to limit itself to the pelvic viscera

3 Infection may occur from without, as in perforating wounds, operations, etc., any of the ordinary pyogenic organisms being responsible. In this connection we would repeat what has been alluded to more than once, viz., that the likelihood of infection depends largely on the peritoneum remaining unbruised and dry. Rough handling and prolonged exposure are only too likely to destroy the surface endothelium and diminish its resisting powers, whilst the same conditions check the power of absorbing fluids, and hence permit of bacterial growth.

4 Peritonitis may be due to the *gonococcus*, and then has usually spread up the Fallopian tube, to the *pneumococcus*, probably as a blood infection, or secondary to pneumonia or pleurisy, the bacteria travelling through the lymphatics of the diaphragm, and possibly to the organism of *acute rheumatism*, then, perhaps, starting in the appendix.

5 The *B. tuberculosis* is responsible for the development of a chronic tuberculous peritonitis.

6 Simple chronic peritonitis is of a protective character, and arises when any irritative lesion of a viscus slowly approaches the peritoneal surface, which becomes thickened in consequence. Adhesions of various types may result from this reaction, and grave developments (obstruction, strangulation, etc.) may follow at a later date.

7 A group of cases occurs in which the causative lesion is mechanical or chemical in the first place, e.g., extravasation of bile from a ruptured gall-bladder, or the irritation produced by torsion of a wandering spleen, of an ovarian cyst, or even of the omentum. Severe reaction follows such a lesion, but it is possible that the focus may be shut off from the general cavity by plastic adhesions, and be thereby encapsuled or absorbed, or the inflammation may extend to neighbouring coils of intestine, and when once these become paralyzed bacterial invasion is almost certain to follow, and septic peritonitis to ensue.

It is interesting to note that a localized immunity can be developed in the peritoneal cavity of animals by injecting gradually increasing

doses of toxic material, it is probable that a similar condition obtains in man, and this explains why the sites of old peritonitic trouble are often favourable for operations, an attack of generalized inflammation being unusual

**Varieties**—From a purely clinical standpoint, peritonitis may be discussed under two main headings—the acute and the chronic. The acute is again divided into the diffuse and localized, and the chronic into the simple and the tuberculous

1 **Acute Diffuse Peritonitis** results from infection of the peritoneal cavity with a large dose of septic material (as by rupture of the stomach or intestine), or by the introduction of a small dose of virulent organisms when the resisting powers are low

**Pathological Anatomy**—The peritoneal surface becomes congested and a little sticky, and its shiny appearance is lost as a result of the proliferation of the endothelial cells and a commencing œdema of the subserous connective tissues, this change is most advanced in the neighbourhood of the site of infection, but rapidly spreads, and in the gravest forms of peritoneal toxæmia, where death takes place under twenty-four hours, there is but little other evidence of the disease. In the great majority of cases, however, effusion occurs, sometimes the fibrinous element is most marked, the intestines being matted together, and the fibrin thickest along the lines of contact of adjacent coils, sometimes there is an abundant serous exudation, but more frequently it is sero-purulent or consists simply of pus, and then gravitates to the loins and pelvis, or may be shut up in pockets by the development of adhesions. The effusion is intensely infective, and the surgeon may wisely protect his hands by rubber gloves, since any wounds caused during operation or in the post-mortem examination are likely to be followed by severe cellulitis or even septicæmia. Gas may be present, resulting either from decomposition of the exudation or from penetration of an air-containing viscus

The contents of the gut stagnate and undergo decomposition. The omentum becomes congested and infiltrated with effusion, or even pus, it may occasionally, however, form a barrier across the abdomen, shutting off the lower from the upper part, and thus limiting the mischief to one or other section

**Symptoms**—The onset varies somewhat with the cause of the affection, but when due to traumatic infection from without, the symptoms usually commence with abdominal pain and distension, together with flatulence and vomiting. The pain may at first be localized to some particular region, or referred to the umbilicus, soon, however, it becomes diffuse, and is associated with exquisite tenderness and great distension. In a typical case the phenomena are very characteristic. The patient lies on his back with the knees drawn up, partly to relax the abdominal muscles, partly to prevent the bedclothes touching the body. The abdomen is distended, hard, and extremely tender, it is at first generally tympanitic, but later on, if effusion should become marked, dulness may be noted in the flanks, although this is not a common feature. The pulse is quick,

hard, and wiry in the early stages, though later it becomes weak, rapid, and compressible. The respirations are quick, shallow, and thoracic in character. The temperature, perhaps raised at first as a result of the causative lesion, tends to become subnormal from toxæmia before the end is reached. Vomiting is usually a prominent symptom, associated perhaps with hiccough, to commence with, the contents of the stomach alone are expelled, but later on they may be mixed with bile, or with the decomposing contents of the upper coils of intestine. Though very constant and troublesome, it is much less distressing than that which arises from intestinal obstruction, and, owing to the pain induced by any sudden contraction of the abdominal muscles, the patient ejects the vomit with but little force. Constipation and the absolute arrest of flatus are almost always present in peritonitis, owing to the cessation of peristalsis induced by the inflammation. As the case progresses, the patient's strength rapidly diminishes, his face becomes pinched and drawn (*facies Hippocratica*), the extremities are cold, the temperature is usually subnormal, and death results from collapse and toxæmia.

When due to sudden perforation of the bowel, the onset of the symptoms is associated with profound shock, and the course is very rapid if the opening is large, and the intestinal contents early extravasated. Vomiting, too, is usually more marked than when due to other causes. If, however, the perforation is small, the immediate shock is less, and the symptoms progress more gradually.

As already mentioned, there are certain grave cases in which the general toxæmia is the most marked phenomenon, and these may succumb from exhaustion in from twelve to twenty-four hours. The majority of cases, however, last for three or four days. Recovery occasionally ensues, and is heralded in by a diminution or cessation of the vomiting and the passage of flatus, whilst the local symptoms gradually clear up. When the disease is due to the gonococcus or pneumococcus, the outlook is more favourable than when streptococci are present.

**Diagnosis**—The clinical features of a case of acute septic peritonitis, as indicated above, are quite characteristic and cannot be mistaken, but if the recognition of the case tarries till this stage is reached, very little prospect of cure can be held out. It must be clearly kept in mind that peritonitis is in the majority of cases a localized affection to start with, and hence, if the earlier stages of the causative lesion can be recognised and treated, the development of the general affection can often be prevented. Reference will be made hereafter to a number of conditions which may simulate peritonitis.

**Treatment**—In former days treatment consisted in fomenting the abdomen, and keeping the patient fully under the influence of opium, whilst abstinence from food was enforced, and possibly calomel given as an absorbent, but since peritonitis usually results from some very definite local lesion, such measures are in most cases obviously inadequate, especially in the early stages when the disease has not involved the whole cavity.

In the later stages, however, when the patient is suffering from severe toxæmia, when the intestines are distended and paralyzed, and when fæcal vomiting is present, it is quite a question whether operation is desirable, and whether the necessarily fatal issue will not be hastened rather than hindered. In such cases, if operation be undertaken at all, it should be limited to a small incision under cocaine anæsthesia in the middle line below the umbilicus, and the introduction of a glass or rubber drainage-tube, or of a strip of gauze, in order to remove the fluid exudate. A larger opening will involve the escape of distended and paralyzed intestines, and to return these even after puncture and removal of the contained gas is often a matter of serious difficulty. It is also probable that complete disinfection of the cavity will be impossible, and the results hitherto gained have been so bad that many surgeons doubt the desirability of operating at all in such hopeless cases.

Apart from the question of operation, the patient is fed *per rectum*, and strychnine administered as a cardiac stimulant. Great relief is gained by washing out the stomach, thereby getting rid of all the foul, decomposing contents.

In the less severe earlier cases operation is certainly the correct treatment, and if not left till too late good results may be anticipated, as in the treatment of perforated gastric ulcer. Details will be given more fully in dealing with the various viscera, but a few general facts may be mentioned here.

The incision is usually made in the linea alba and below the umbilicus, unless there is some definite indication that the causative lesion is in the upper part of the abdomen. The effusion has then to be removed, the intestines cleansed, and the cause dealt with. This last indication is discussed elsewhere. The practice of various surgeons differs as to the best way of cleansing the peritoneum. Some consider *irrigation* the best plan, using salt solution at a temperature of about 107° F for the purpose. It is usually advisable to make counter-openings and insert a large drainage-tube in each loin if this is undertaken, and Douglas's pouch must be well washed out and drained. Others maintain that mopping up the effusion with dry sterile swabs and employing no fluid to wash it with is the better practice, and certainly excellent results can be pointed to. Probably both methods are right in certain cases. Where the effusion is localized and not diffuse, as is so common, the dry method is certainly desirable. Irrigation would be only too likely to disseminate the mischief. When, however, there is much generalized effusion, as in some cases of perforated gastric ulcer, irrigation may be wisely undertaken. Another question arises as to the desirability or not of *evisceration*, and the complete and thorough cleansing of all the coils of intestine under a stream of hot salt solution. There can be no question that this procedure seriously adds to the shock of operation, and except in very favourable and special cases we do not consider it advisable. Drainage is necessary in almost all cases, and may be effected by glass or rubber tubes with or without gauze wicks.

(p 963) The importance of overcoming the intestinal paralysis is so great that it has been suggested by McCosh that several ounces of a saturated solution of Epsom salts should be injected into the upper part of the jejunum before closing the abdomen. The advice is sound, and the practical results that have been reported hitherto satisfactory.

In cases of threatening peritonitis following abdominal operations, as indicated by pain, distension, and vomiting (*peritonism*), the chief causative factor is often a paralytic condition of the gut, which permits of the retention and decomposition of the intestinal contents, thus assisting the activity of the *B coli*. In such cases a smart saline purgative (*e g*, sodi sulphas, gr  $\lambda\lambda$ ,  $\lambda\lambda\lambda$ , every hour) is often useful, in order to free the intestine from its irritating contents. When, however, general septic peritonitis is present, purgatives can only do harm.

2 **Acute Localized Peritonitis** usually arises in connection with some limited lesion of the abdominal contents, which is of such a nature as to permit of the general peritoneal cavity being shut off by adhesions, the process being thereby localized. It is frequently followed by suppuration, the abscess being thus intraperitoneal, although not involving the general peritoneal cavity. The abscesses arising in connection with appendicitis or pelvic peritonitis are not uncommonly of this nature. They may burst through the barrier of adhesions, and thus light up a diffuse inflammation of the peritoneal sac, or they may burrow to the surface and point externally, or open into one of the hollow viscera.

The **Symptoms** complained of are deep pain and tenderness, more or less localized to the affected area, together with fever, vomiting, and constipation. At first no swelling or tumour is to be made out, but a feeling of resistance may be noticed in the abdominal wall, which is held tense and rigid, as if guarding some focal point of mischief. As the effusion increases in amount, a tumour dull or tympanitic on percussion may become evident, it is mainly due to a matting together of the intestines and omentum, but is often associated with a variable amount of effusion, if, however, it is placed deeply, the dulness may be absent owing to the fixation of one or more coils of intestine in front of the inflammatory focus. If an abscess forms and travels towards the surface, the abdominal wall becomes infiltrated, red, and œdematous, the component tissues being brawny to the touch, and cutting like bacon. Finally, a fluctuating area presents itself in the midst of this indurated mass, and the abscess either discharges itself or is opened. The pus contained therein may be thin and offensive, or it may be free from odour, and then is often somewhat inspissated, and like custard in consistency. Of course this process is attended with considerable increase in the pain and constitutional disturbance. If the cavity is treated antiseptically, it rapidly contracts and a cure is accomplished, although intraperitoneal adhesions may persist and lead to trouble later on from hampering the intestinal movements. If a communication is established with

the intestine, a faecal fistula is apt to follow, whilst if the cavity becomes septic, chronic suppuration may result, and thereby the patient's health and strength are undermined. The determination as to the existence or not of suppuration in these cases is by no means easy, and a blood count is often of the greatest value (see p 48).

**Treatment**—In these cases, resolution can be obtained in favourable cases by keeping the patient quiet and on a low diet, with perhaps a little morphia, and by applying fomentations locally, whilst the lower bowel is emptied by an enema. Such a course must, however, not be persisted in for too long when suppuration is likely to have occurred, for fear of the inflammation spreading to the general peritoneal cavity, or of the abscess bursting into it. An early exploratory laparotomy is advisable under such circumstances. The line of treatment marked out for appendicitis (p 1041) is that which should always be followed.

**3 Simple Chronic Peritonitis** in itself rarely requires surgical attention, since it is to be looked on rather as a protective than as a destructive process. It is characterized by infiltration and thickening of the peritoneum, giving rise to adhesions, whereby the intestinal wall is strengthened and bacterial invasion hindered. It is localized or diffuse in character, and arises as the result of some pre-existing inflammation. In the more diffuse forms it is due to a cured septic or tuberculous peritonitis, and then the intestines may be hopelessly matted together, or the omentum rolled up and contracted into a rounded cord-like mass, lying transversely across the upper part of the abdomen, chronic obstruction is almost certain to arise sooner or later from this condition.

More frequently it is the consequence of some localized injury or inflammation. In the former plastic lymph is deposited over any breach of continuity of the serous membrane, and to this the omentum or intestine becomes adherent, the under surface of a laparotomy wound is not unfrequently affected in this way. Localized areas of inflammation are similarly liable to originate adhesions, which are thus found in connection with gastric ulcers, an inflamed vermiform appendix, enlarged mesenteric glands, or pyosalpinx. Under favouring circumstances many such adhesions are absorbed in the early stages, but if they persist they are modified by the intestinal movements, and are likely to become lengthened and rounded, thus originating the bands and cord-like structures so often the causes of acute obstruction. The anatomical arrangements of the omentum explain why this structure is so frequently involved in this process, and thereby it constitutes one of the most important agents for checking the spread of inflammatory affections. Intestinal adhesions often give rise to no symptoms, but sometimes they determine attacks of colic and of irregular peristalsis, and occasionally an adhesion to the abdominal wall (*e g*, one springing from the stomach) causes a localized constant pain which justifies exploration.

**4 Tuberculous Peritonitis**—This disease is almost limited to young people, and is usually secondary to some other focus of tuber-

culosis, *e g*, in the intestine, mesenteric glands, Fallopian tube, testis, etc. It is sometimes limited in its development to a portion of the peritoneal cavity, especially when originating from the pelvis or vermiform appendix, but is more frequently diffuse. It manifests itself in several different ways, which may be associated with or follow one another. (1) In the *ascitic* variety the peritoneum becomes thick and hyperæmic, and is studded over with tubercles, some of them small, gray and translucent, others larger and undergoing caseation. The effusion is generally abundant, and consists of straw-coloured or opalescent serum, perhaps blood-stained in the more active cases. Flakes of fibrin may be found covering the membrane here and there, but there is no extensive matting of the intestines. Occasionally the effusion becomes encapsuled, giving rise to cystic swellings shut in between the coils of intestine. (2) In the *fibrous* variety the intestines become matted together by extensive adhesions, and between them foci of tubercle are found. The mesentery may become infiltrated and shrink, fixing the intestines back *en bloc* to the posterior abdominal wall. The omentum is often invaded, and contracts upwards to form a sausage-like tumour lying transversely above the umbilicus. There is but little effusion, and that is usually encapsuled. It is obvious that such a condition is very likely to lead to obstructive phenomena, due to kinking of the intestine. (3) The *ulcerous* variety is characterized by an exaggeration of the above phenomena. Tuberculous foci of some size are found between the coils of intestine, caseation and suppuration follow, and the abscesses are likely either to open into the intestine, possibly into two coils, causing thereby a fistulous communication, or perhaps to travel to the surface and open externally, and then most frequently at the umbilicus, possibly giving rise to a fæcal fistula.

In each of these varieties acute manifestations may develop at any time as a result of infection from the bowel with the *B coli*, and then the symptoms of acute diffuse peritonitis may supervene.

The **Symptoms** are extremely variable, and the early stages of the disease are sometimes not easy to recognise.

A few cases have an *acute* onset with abdominal pain and distension, and continued pyrexia which may suggest the existence of enteric fever. The abdominal wall, however, is not rigid, the tenderness is not great, there is well-marked evidence of free fluid, and though vomiting and constipation may be present, they are not marked features. Naturally the patient in such a condition wastes quickly.

In the more *chronic* forms the earliest symptoms are weakness with some slight abdominal discomfort, and not uncommonly diarrhœa, alternating, perhaps, with constipation. The temperature becomes of a hectic type, and periods of improvement may alternate with attacks of increasing pain and weakness. On the whole, the patient gradually gets worse, his wasted frame comparing markedly with the protuberant and enlarged belly. The phenomena discoverable on abdominal palpation vary considerably with the conditions present within.

**Treatment** in the early stages is often successfully undertaken by

the physician Hygienic measures are adopted, the patient living in the fresh air, and, of course, being always in the recumbent position Plenty of good digestible food is given, as also cod-liver oil and perhaps intestinal antiseptics, such as salol, creasote, etc The external application to the abdomen of iodine, either as a paint or an ointment, is much commended by some physicians Should the condition undergo no improvement, it may be justifiable to operate When marked ascitic accumulation is present, all that is needed is to remove the fluid and close the wound with or without irrigation, and in nearly 75 per cent of the cases a cure may be anticipated In the acute forms, however, infection of the wound may follow the escape of the highly infective fluid from the peritoneal cavity, and healing may be thereby delayed Where diffuse or localized suppuration is present, adhesions which can be reached may be gently broken down, exit given to the pus, and the peritoneal cavity washed out, but no prolonged search after suppurating foci should be made, or the intestine may be torn The results of treatment in this variety are not nearly as satisfactory as in the former, at least 40 per cent of the cases dying As to the way in which cure is established, opinions differ, some authorities considering that it is due merely to the admission of atmospheric air, some to the alteration produced thereby in the intra-abdominal tension, whilst others maintain that it is simply in consequence of the removal of the exudation and its contained toxins The most plausible idea, however, attributes it to a flushing of the intra-abdominal tissues with blood plasma (a well-ascertained fact after laparotomy) and the effect of the antitoxic substances contained therein, the tubercles thereby having their vitality destroyed In this connection one may note the statement that too early a laparotomy does but little good, an insufficient amount of antitoxin having presumably developed in the system

**Subphrenic Abscess** is the term applied somewhat loosely to a suppurating focus which is in more or less intimate relation with the under surface of the diaphragm Two main varieties are described, viz, the intraperitoneal, which is much the more common, and the retro- or extra-peritoneal The *causes* are very diverse, and the manifestations vary somewhat with the causative lesion 1 The *stomach* is the most frequent source of the trouble, the infection being due to the extension of a chronic ulcer If the *anterior wall* is involved, the pus will be limited by the lesser omentum and stomach behind, by the diaphragm and left lobe of the liver above, by the falciform ligament on the right, and by adhesions between the stomach or omentum and anterior abdominal wall below This type of abscess usually points to the left of the ensiform appendix Should the ulcer be situated on the anterior wall near to the fundus, the abscess may get into close relationship with the spleen, and point beneath the left costal margin When the abscess arises in relation with the *posterior wall*, the lesser sac of the peritoneum may be filled with pus, which is prevented from escaping from the foramen of Winslow by adhesions, whilst the stomach itself is pushed forwards, and the pus travels up and



presents above it to the left of the middle line. More often the lesser sac has been previously obliterated, and the abscess develops in the retroperitoneal tissues. 2 Ulcer of the *duodenum* may give rise to very similar conditions. If the abscess is intraperitoneal, it is bounded by the liver, colon, omentum, and anterior abdominal wall, occasionally it has also tracked up behind the liver. Retroperitoneal suppuration also occurs in connection with the duodenum, the pus then travelling up between the liver and diaphragm, or downwards towards the loin. 3 The *appendix vermiformis* is also a cause of subphrenic abscess, the pus burrowing behind the peritoneum, or finding its way along the inner or outer walls of the ascending colon. 4 It may also be caused by extension of suppuration from the liver, colon, intestine, or from retroperitoneal structures, such as the kidney, ribs, or vertebrae. According to Fenwick, however, 80 per cent of all cases of subphrenic abscess are due to ulceration of the stomach or duodenum.

The abscess thus induced may contain pus alone or, in addition, gas, which is derived either from a direct communication with the bowel, or from the activity of the *B. coli* without any definite opening being present. It was to this condition that Leyden originally gave the name of *subphrenic pyo-pneumothorax*. The extension of the abscess along the under surface of the diaphragm often leads to that structure being displaced considerably upwards, and to a secondary infection of the pleura, either by lymphatic absorption and extension, or by an actual solution of continuity. The effect is an effusion of serum or pus into the base of the pleural cavity, the latter constituting a basal empyema.

The **Symptoms** vary considerably. They may be preceded by those referable to the causative lesion, and their onset may be sudden or gradual. Ordinary febrile phenomena, and perhaps one or more rigors, may occur, whilst the patient complains of pain in the upper part of the abdomen, together with vomiting and constipation. The pain is often increased on respiratory movements, and may extend upwards to the shoulder. On palpation, the abdominal muscles on one or other side are held rigidly contracted, but possibly a swelling, either dull or tympanitic according to its contents, may be noted. There may be some bulging of the intercostal spaces. On the right side the diaphragm may be pushed up, and the liver downwards, and if the abscess contains gas, an area of tympanitic resonance may be noted between the dulness of the liver and the resonance of the lung. On the left side, the heart may be pushed upwards together with the diaphragm, and the absence of lateral displacement of the heart is an important diagnostic feature from a pure empyema or pneumothorax. The X rays will sometimes be useful in recognising displacement upwards of the diaphragm, and immobility of the affected half. A blood count is important in indicating the existence of suppuration.

The **Treatment** consists in opening and draining the abscess wherever it is most accessible. In many cases this can be effected through the anterior abdominal wall along the lower margin of the

ribs, but even then a counter-opening is often needed behind. When the abscess does not project anteriorly, the best situation for an opening is through the pleural cavity, as for some abscesses of the liver. The incision lies behind the mid-axillary line, a portion of the eighth or ninth rib being excised. If, as often happens, there is also an empyema, this is opened and drained, and then an additional opening can be made through the diaphragm if one does not already exist, if, however, the pleural cavity is not affected, the serous membrane covering the upper surface of the diaphragm must be stitched to the parietal pleura before the diaphragm is incised.

**Ascites**—By this term is meant an accumulation of fluid, and that usually of a serous type, within the peritoneal cavity. It results chiefly from lesions which fall to the care of the physician—viz, cirrhosis of the liver, chronic Bright's disease, and various cardiac affections. It is also a consequence of any obstructive pressure on the portal vein, as by malignant glands in the portal fissure secondary to carcinoma of the stomach or of the intestine, or by fibrous adhesions, the consequence of duodenal ulceration or stones in the gall-bladder. Fluid also collects in the abdomen as the result of diffuse malignant deposits scattered over the peritoneum, or from the presence of mildly irritative foci, such as hydatid cysts, etc. *Chylous* ascites is a condition in which the fluid is milky from an admixture of chyle, and usually results from rupture of the receptaculum chyli in consequence of the pressure on the thoracic duct above it of malignant glands secondary to cancer of the stomach. *Encysted* ascites results from the distension of a portion of the cavity which has been shut off by inflammatory adhesions.

The **Physical Conditions** resulting from ascites are easy of recognition. The abdomen is distended, like a barrel, but with bulging flanks. Dulness is present in the loins when the patient is recumbent, and extends forwards to about the same level all round, the only resonant area being about the umbilicus, this is due to the floating forward of the intestines. On rolling the patient over to one side, the dull and resonant areas shift, the part that is highest becoming resonant. This sign is occasionally absent if the mesentery is short or if the intestines are tied down posteriorly. On tapping the abdomen, a well marked thrill is usually transmitted from one side to the other. Necessarily, the fluid also finds its way into any diverticula of the peritoneum, such as an unclosed funicular process or a hernial sac. The **diagnosis** of ascites should present no difficulty, but the practitioner must not be satisfied until he has found the cause of its presence, and this may not be easy even when the fluid has been removed, so that the abdominal viscera are palpable.

**Treatment** necessarily varies with the cause of the accumulation. Should it persist, and the patient's breathing be hampered by the abdominal distension, removal by *paracentesis* is essential. The usual plan adopted is to seat the patient on a chair and to encircle the abdomen with a flannel binder, the ends of which are split to within 6 inches of the middle line. The unsplit portion is placed over the

abdominal wall in front, whilst the divided portions cross behind, and are held by assistants, so as to make continuous pressure upon the abdominal contents. The bladder is completely emptied, and then the abdomen is carefully percussed, and a spot of absolute dulness selected, here a small skin incision is made with a scalpel, and a suitable trocar and cannula inserted. The median line below the umbilicus is the place usually chosen for the puncture, but there is no objection to inserting the trocar through the flanks. Some surgeons prefer to withdraw the fluid more slowly, so as to prevent the shock often experienced from its rapid removal. Two or three Southey's trocars and cannulæ may then be inserted.

Not unfrequently the fluid re-accumulates, and the process has to be repeated after a time. When the cause of the collection is doubtful, the practitioner will take the opportunity of the lax abdominal wall to palpate the viscera, light may also be thrown on an obscure case by a cytological examination of the fluid. In malignant disease, cancer cells and blood may often be found. If the condition is still doubtful, an exploratory laparotomy may be advisable.

In cases due to hepatic cirrhosis, Talma's operation of **Epiploexy** may possibly be justifiable. The object is to relieve the obstruction to the portal system by opening up fresh communications between it and the systemic veins. The method consists in fixing the great omentum to the abdominal wall and determining the formation of adhesions, necessarily the peritoneum has to be drained and kept dry during this procedure, and the question arises as to whether this drainage is not the cause of the improvement. The mortality is not inconsiderable, especially when the liver is small. The best results have been gained with hypertrophic cirrhosis. The method is still on its trial, but appears to be justifiable in suitable cases.

### Affections of the Great Omentum

The omentum is of great surgical importance in the abdomen, in that it covers in and protects the viscera, and by its mobility is able to apply itself to many a weak spot where perforation or infection might occur, and thereby protect the patient from serious inflammatory mischief. The result of this protection is, however, the formation of adhesions which by the irritation of constant movement may stretch and become rounded and cord-like, and various forms of intestinal obstruction (by strangulation, kinking, etc.) may result therefrom. The value of this protective power of the omentum is recognised by surgeons in the employment of *omental grafts* to add security to a line of junction in the intestinal wall with which they are not quite satisfied. It is only occasionally that such a provision is required. The best method to adopt is to detach the graft entirely from its former connections, wrap it round the gut, and stitch it in place.

The omentum may be torn, and holes may be formed in it as a result of **injury**. The immediate symptoms would be pain, shock, and the phenomena of intraperitoneal hæmorrhage, but it is likely that

other injuries co exist At a later date the hole might determine an attack of internal strangulation

**Acute Inflammation** (epiploitis) has been lighted up as a result of the application to the omentum in a hernia operation of a septic ligature The phenomena vary with the virulence of the organisms, an acute diffuse peritonitis perhaps resulting In the milder forms a localized inflammatory disturbance follows, with all the phenomena of a limited peritonitis, suppuration may ensue, and a large intra-peritoneal collection of pus may result

**Torsion** of the omentum is an occasional complication of an irreducible hernia, and that usually on the right side The lesion generally follows some heavy strain, and results in venous stasis, effusion of a blood-stained fluid, the formation of extensive adhesions, and possibly gangrene and general peritonitis, if left long enough The symptoms often start abruptly with colicky pain in the right iliac fossa and scrotum, together with constipation and sickness, the hernial swelling becomes enlarged, and extending upwards from the iliac region a sensitive mass may be detected on palpation, which is dull on percussion, and sometimes reaches to the epigastrium The temperature is normal, though the pulse-rate is accelerated Treatment is obviously operative, and consists in removal of the omentum

Chronic peritonitis, whether simple or tuberculous, may cause the omentum to be rolled up into a more or less solid mass, which lies transversely across the abdomen a little above the umbilicus There is usually a band of clear resonance between it and the hepatic dulness, which is of great diagnostic importance

The omentum also becomes infiltrated with secondary cancerous nodules, which can not unfrequently be palpated, and their presence gives important indications as to the desirability or not of operative treatment Colloid degeneration is not uncommon in omental cancers, and huge masses of this growth have been sometimes discovered in the deadhouse Omental carcinoma usually leads to a considerable effusion of fluid into the peritoneal sac

### Affections of the Mesentery

**Wounds** result from penetrating or non penetrating injuries They are usually associated with laceration of the intestine, and the resulting phenomena will be those of hæmorrhage, followed by general peritonitis from the intestinal lesion Pure mesenteric wounds not involving the intestine are usually due to penetrating or gunshot injuries Hæmorrhage to a varying degree may result, and if the patient lives the nutrition of the intestine may be seriously endangered If such a lesion is found on exploration, bleeding points must be secured and the opening in the mesentery closed, before this is accomplished, however, careful consideration must be given to the vascular supply of the intestine, as the ligature of a main branch of a mesenteric artery may determine gangrene, and necessitate resection of a portion of the bowel

**Thrombosis of the Mesenteric Vessels**, apart from strangulation or volvulus, is usually the result of embolic obstruction of the artery, but may sometimes commence in the veins, spreading down from the liver, or originating in some intestinal ulcer. The process is associated with acute pain, and is followed by the symptoms of acute obstruction. The bowel becomes engorged with venous blood and dies, it is often occupied by a blood-stained effusion, and the passage of dark tarry stools may be noted. The peritoneal cavity contains a quantity of blood-stained serum, which after a time becomes offensive. A diagnosis is rarely reached before operation for the obstructive phenomena, and the only hope for the patient is removal of the gangrenous bowel (if that be possible), and a temporary enterostomy. Should the patient live, a very doubtful contingency, the continuity of the gut may be subsequently restored.

The **Mesenteric Glands** frequently become inflamed in consequence of some intestinal lesion, *e g*, typhoid ulceration. No special notice is taken of this occurrence, unless suppuration ensues, when the abscess must be opened. In less severe cases, however, it is often associated with a patch of localized peritonitis, resulting in the deposit of plastic lymph, to this some other viscus, *e g*, the free end of the omentum, the fimbriated extremity of the Fallopian tube, the vermiform appendix, one of the appendices epiploicæ, etc, may become adherent, and an adhesion may develop which subsequently leads to intestinal obstruction. As a matter of fact, the great majority of intra-abdominal bands are connected at one end with the mesentery.

**Tuberculous Disease** of the mesenteric glands is a common affection in children, constituting a condition known as *tabes mesenterica*. It is probably secondary to intestinal lesions, and when widely diffused through the mesentery is, of course, to be dealt with only by hygienic and medical measures. Limited masses in the iliac fossa may sometimes be amenable to surgical measures, and be removed, whilst occasionally the surgeon has to deal with a gland which has suppurated, and requires to be opened with the same precautions as one would take in dealing with an appendix abscess. Peritonitis, acute or tuberculous, may result from this disease.

**Cysts** of the mesentery are not common, and, as might be expected, they are usually of lymphatic origin, they may be single, containing either lymph or chyle, or multiple, then constituting a cavernous lymphangioma. Blood cysts have also been known. A rounded, tense intra-abdominal swelling gradually develops behind or below the umbilicus, it is freely moveable from side to side, and is usually accompanied by some derangement of intestinal movement or function. When of large size, the swelling is dull, but is often crossed by the affected loop of bowel. It is likely to be mistaken either for an ovarian cyst or for a pancreatic cyst. The diagnosis is usually made on the operating-table, and the treatment consists in enucleation or drainage, with or without removal of the affected coil of intestine.

**Tumours** form occasionally in the root of the mesentery and behind it, constituting the retroperitoneal lipoma, or sarcoma. The former

may grow to a large size, and destroy life by its pressure phenomena, the latter, though sometimes resembling the former in structure, invades surrounding tissues earlier. The diagnosis is uncertain until the abdomen is opened, and the question of removal is dependent on the relation of the growth to the mesenteric vessels, which must not be injured. It is seldom that a retro-peritoneal sarcoma can be enucleated.

### Affections of the Stomach

**Rupture of the Stomach** results from blows or falls upon the epigastrium, especially after a heavy meal, and then usually involves the pyloric end or the greater curvature near the cardiac orifice. It may also follow a penetrating injury, such as a stab or a fall upon a spike or railings. Neighbouring viscera are not unfrequently involved in the lesion, especially the liver or spleen.

The **Symptoms** are those of severe and prolonged shock, with epigastric pain and vomiting, the ejected material often containing blood, acute septic peritonitis usually ensues in a very short time, destroying the patient's life in a few days. Occasionally, when the wound is small or the organ empty at the time of the accident, there is but little or no extravasation, and then a localized intra-peritoneal abscess may form, shut off from the general peritoneal cavity by adhesions, and sooner or later bursting and discharging into the stomach, colon, or one of the hollow viscera, or else coming to the surface and bursting externally, sometimes the barrier of adhesions will give way, and a late general peritonitis may result. If the posterior wall of the stomach is alone injured, the resulting phenomena are very similar to those due to the perforation of an ulcer in this region (*q v*).

**Treatment** — No time must be lost in undertaking a laparotomy when the diagnosis is tolerably certain, since the only hope of saving the patient's life lies in early interference. A median incision is made above the umbilicus, the situation of the injury in the stomach ascertained, and the aperture clamped by forceps so as to prevent any further exit of the gastric contents whilst the peritoneum is being cleansed. All extravasated material should be carefully sponged or swabbed away, and if the general cavity has not yet become inflamed, irrigation should be avoided for fear of carrying infective material to other regions. The wound in the stomach is closed by a row of Lembert's sutures, which tuck the margins inwards, and these must extend a little beyond the lesion on either side (Figs 354 and 355). If the posterior wall is also injured, as by a bullet wound, an opening should be made through the omentum so as to explore and cleanse the lesser sac of the peritoneum. If the case has been operated on early and there is but little peritoneal inflammation, it may be possible to close the parietal wound entirely, but, as a rule, it is necessary to drain the upper part of the serous cavity by inserting a plug of gauze down to and around the site of the injury. If the general cavity is inflamed, the treatment suitable to acute peritonitis must be instituted (p 975). It will probably be

wise under these circumstances to place a drainage-tube immediately above the symphysis pubis, reaching down into Douglas's pouch, as well as making counter-openings in the loins and leaving the upper incision partly open

**Foreign Bodies** in the stomach consist either of those which have been swallowed accidentally or intentionally, or of concretions, *e.g.*, hairs, wool, etc., due to the constant ingestion of small portions which remain in the viscus, and may after a time form large masses. The presence of the former is known from the history, whilst the latter may give rise to symptoms of gastric irritation, the cause of which is inexplicable until the mass has attained such a size as to suggest the presence of a tumour. The only treatment possible for a foreign body of any size is to open the organ and remove it (gastrotomy), where, however, it is of small dimensions, *e.g.*, a coin, it may be allowed to pass onwards.

**Ulcer of the Stomach** is an exceedingly common ailment, the consequences of which are often very serious, a considerable mortality being associated with it, its complications, or its sequelæ. Two chief types may be mentioned here, although others are not unknown.

(a) The **acute ulcer** is rarely larger than a sixpenny-piece, and 'develops with almost equal frequency at any spot between the cardia and the pylorus along the upper margin of the stomach, and more frequently on the posterior than on the anterior surface' (Fenwick). It is not unusually multiple, two ulcers being often found exactly opposite one another, suggesting an infective origin of the trouble. They are of a circular shape, and with the edges sharply defined and clearly cut, each successive coat is destroyed to a lesser degree than the one internal to it, so that the sore is truncated or funnel-shaped. Should perforation occur, the opening is not central, but slightly to one side. These acute ulcers heal without much difficulty, as is evident from the number of radiating cicatrices seen on the post-mortem table. They give rise to no stenosis, except perhaps when they are situated within the pyloric orifice. Hæmorrhage from this variety is not uncommon, but is rarely fatal\*.

(b) The **chronic ulcer** may attain considerable dimensions, perhaps many square inches of each surface being involved. It is usually single, and situated on the posterior wall near the pyloric orifice, which may be involved in the trouble by extension. Its shape is very variable, though in the earlier stages it is rounded, one important type is the horseshoe ulcer, which spreads down along either surface from the lesser curvature, and may subsequently cause an hour-glass contraction of the organ. The edges are often raised, hard, and infiltrated, whilst the gastric wall is generally thick and sclerosed. In old-standing cases there may be considerable destruction of tissue, external viscera, such as the pancreas, being sometimes exposed in the wound. Hæmorrhage is not uncommon, and

\* See Fenwick, 'Ulcer of the Stomach and Duodenum' J and A Churchill, 1900 and Mayo Robson and Moynihan, 'Diseases of the Stomach and their Surgical Treatment,' Baillière, Tindall and Cox, 1901

may prove fatal, one of the larger branches of the coronary artery, or perhaps the splenic, is then involved, or the bleeding may arise from one of the enlarged varicose gastric veins which are often found in the neighbourhood of an old ulcer. Perigastric inflammation of an adhesive or suppurative type is almost certain to occur, and cicatricial contraction of various forms is likely to follow.

Women are much more liable to gastric ulcer than men, in the proportion of three to one, but it is the acute variety to which they are most prone, and from which, apart from perforation, they seldom die. The usual age of such patients is from fifteen to thirty years. Men, on the other hand, are more liable to chronic ulcers, and though acute perforation is less common, they are subject to a number of serious complications which may prove fatal. Their average age when attacked is from thirty to fifty years.

Into the ætiology, general symptoms, and routine treatment of gastric ulcers it is unnecessary to enter, they are sufficiently described in medical text-books. A number of complications, however, arise which may require surgical assistance, whilst it must be remembered that the mere persistence of symptoms may justify operative measures, especially since the observation has been made and confirmed that malignant disease may commence on the site of an old-standing ulcer.

1 **Excessive and Persistent Hæmorrhage** is responsible for quite a considerable proportion of the deaths from gastric ulcer. It may arise from arteries, veins, or capillaries, and at first it is difficult to say from what source it is derived. Inasmuch, however, as in over 90 per cent of the cases it can be stopped by medical means, it is obvious that the capillary origin is most common. It is uncommon for the patient to succumb to the first attack of bleeding, and hence the rule of practice which is usually adopted, viz, to treat the first acute hæmorrhage by medical means, but should it recur or persist unduly, surgical assistance may be required.

If the bleeding is small in amount, but recurs constantly, gastro-enterostomy should be undertaken, in order to put the organ at rest and allow the ulcer to heal. When, however, the hæmorrhage is more severe, a determined attempt must be made to find the bleeding spot and deal with it. The abdomen is opened and the stomach carefully explored. Some puckering or thickening of the coats may indicate the situation of the ulcer, failing this, a free opening in the longitudinal axis is made through the anterior wall, and the interior of the viscus methodically examined. When the bleeding point has been found, it may be possible to pick it up and tie it, or the whole ulcer may be picked up and ligatured *en masse*, or the base of the ulcer may be cauterized, or excision of the ulcer may be practicable. Failing these measures, gastro-enterostomy will be indicated, and the result is usually satisfactory.

2 **Perforation of the Ulcer** is by no means an uncommon occurrence in connection with the acute type of ulcer, and is therefore seen most frequently in young women, it is always fraught with the



greatest danger. The anterior wall is more frequently involved than the posterior (7 to 1), owing to its greater mobility, which prevents the formation of protective adhesions. The cardiac end is more often affected than the pyloric (5 to 3), whilst the opening is usually nearer the lesser rather than the greater curvature. The character of the symptoms varies with the size of the perforation, and with the distension or not of the viscus. If a large opening is produced in the anterior wall, so that the gastric contents are allowed a free entrance into the peritoneal cavity, the patient is seized with severe epigastric pain and profound shock, and this is followed by acute septic peritonitis, which rapidly proves fatal if surgical interference is not at hand. When the perforation is small, and only a gradual leakage occurs, the onset is subacute, the primary shock is then inconsiderable, but epigastric pain and tenderness are present, together with marked rigidity of the abdominal wall, a short period of improvement follows the primary shock, and then the symptoms steadily increase until the characteristic features of general peritonitis supervene.

The *Prognosis* of gastric perforation is exceedingly grave, since, unless active surgical interference is obtainable within a comparatively short time, hopeless peritonitis ensues. Statistics indicate that 95 per cent of untreated patients die, whilst the later the operation, the worse the results.

*Treatment*—Should it be decided for any particular reason not to operate in a given case, the horizontal position, rectal feeding, and the use of morphia to check peristalsis, are the only means which hold out any prospect of benefit. Operation, as already indicated, must be undertaken at as early a period as possible, although it is often wise to delay for an hour or two to allow the patient to recover in measure from the initial shock. The median incision is the best to employ, since it is not possible to be certain as to the situation of the lesion. The rules given above as to the treatment of a penetrating injury hold good in connection with this subject, especially as to the use of swabs for the removal of any extravasated gastric contents, and as to the value of peritoneal irrigation. There is no need to excise the ulcer when found, all that is required is to close the aperture by means of Lembert's sutures, applied perhaps in a purse-string fashion, so as to bury the ulcerated surface. In some cases it may seem unwise to attempt closure of the lesion, whilst in others it may be so situated as to render such closure impossible, a drainage-tube, free from lateral openings, is then introduced into the stomach, and gauze packed around it so as to lessen the risk of intraperitoneal leakage. The patient is fed by the rectum for some time, and the fistula usually closes without much difficulty at a subsequent date.

3 **Perigastric Inflammation** is a common result of ulceration, it may be either adhesive or suppurative in character.

*Adhesive Perigastritis* is in the first place protective in nature, consisting of a localized thickening of the serous wall. It is more marked in connection with chronic than with acute ulcers. The posterior gastric wall is often adherent across the lesser sac of the

peritoneum to the serous membrane lying in front of the pancreas, and this fixity may be one of the factors which prevent the ulcer from healing, even as fixation to the periosteum over the tibia delays healing in an ulcer of the leg

In a few cases adhesions form between the anterior wall of the stomach and the parietal peritoneum, and these may give rise to a localized fixed epigastric pain, usually increased considerably by distension of the organ. It may be treated safely by abdominal section, and division of the adhesion between ligatures. If left alone, not only may it cause inconvenience by the pain induced, but it may also determine internal strangulation or obstruction.

*Suppurative Perigastritis* may follow a small perforation with limited leakage, but is more usually due to an extension of the ulcer and an invasion of the perigastric tissues by organisms which escape from the stomach. The result of this is the formation of what has been already described as a subphrenic abscess (p. 979), which may or may not contain gas. It may burst anteriorly through the abdominal wall, or may perforate the diaphragm, giving rise to a basal empyema, and this in turn may burst into the lung or through the chest wall, so that fistulæ may appear in various places, through which the contents of the stomach may be discharged.

The abscess should be opened and drained in the way already indicated, but should a fistula form, it is almost hopeless to attempt to deal with it locally, and a gastro-enterostomy may then be required.

4 **Stenosis** is always liable to follow the cicatrization of ulcers of the stomach. In the small acute ulcer the contraction rarely leads to more than a puckering of the organ, but in the chronic ulcers of large size the organ may be much altered in shape, and definite stenosis may arise. If the contraction is in or near the cardiac orifice, symptoms akin to œsophageal stenosis may be produced, the patient returning his food shortly after swallowing it. If the pylorus is affected, the stomach is often much dilated, and vomiting of a special type ensues (see Simple Stenosis of the Pylorus, p. 995). It is important to note that muscular spasm plays a considerable part in the production of these symptoms when due to ulcer, the spasm is probably induced by the hyper-acidity of the gastric juice (hyperchlorhydria) which is often present.

The most exaggerated forms of gastric stenosis follow the cicatrization of a horse-shoe ulcer, and this constitutes the most common cause of an *hour-glass stomach*. Adhesive perigastritis and cancer are occasional causes. The constriction is usually situated about 4 inches from the pylorus, and may be so narrow as almost to divide the organ into two halves. Generally the great convexity is drawn up towards the lesser, and thereby two pouches are formed which sag downwards, in them food collects and undergoes decomposition. Vomiting more or less of a pyloric type ensues from the distension of the cardiac pouch, which is usually much the larger. On washing out the organ with a measured quantity of water, a

smaller quantity often returns, some being retained in the lesser sac. On palpation this latter may occasion a succussion splash, even when the organ is apparently empty. On again passing the tube after a short interval, offensive fluid may return, especially if the pyloric pouch has been palpated. Distension of the viscus (as by passing a stomach-tube and forcing air in with a bicycle pump) causes a definite bulging on the left side of the epigastrium in the first place, subsequently this may diminish, and the pyloric pouch become evident on the right side. Sometimes both pouches can be distinctly felt, or even seen, as well as the sulcus between them. No treatment is of any avail which does not provide for the drainage of both pouches and the efficient emptying of the whole organ. A few cases may be treated by excision of the stricture, or by its longitudinal

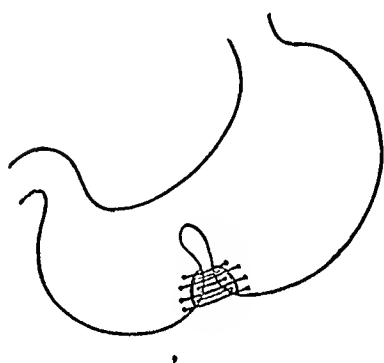


FIG 360 — HOUR GLASS STOMACH, INDICATING THE METHOD OF TREATMENT BY ANASTOMOSIS OF THE TWO POUCHES

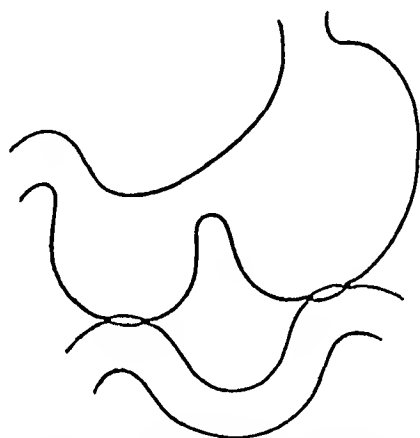


FIG 361 — TREATMENT OF HOUR-GLASS STOMACH BY DOUBLE GASTRO-ENTEROSTOMY

division and suture transversely by a method similar to that employed for the pylorus (see Pyloroplasty, p 1001). In some cases the two pouches may be united below the stricture (Fig 360), but there can be no question that the great majority are best dealt with by a double gastro-enterostomy (Fig 361), which gives a direct communication between each segment and the jejunum.

5 Finally, cases are met with in which the symptoms of gastric ulcer persist or recur in spite of the most careful dieting and treatment, and it is now considered quite justifiable to submit such cases to operation. Two lines of treatment are possible. (a) The ulcer may be excised, if it be in a convenient position for such a procedure, and if the infiltration around it is not too extensive. This is, however, rarely practicable. (b) In most cases gastro-enterostomy (p 1001) should be undertaken in order to relieve symptoms by enabling the viscus more readily to empty itself after the ingestion of food. The stomach is thereby put at rest, the ulcer is able to

heal, the patient's nutrition is quickly re-established, and the results are in every way gratifying

**Cancer of the Stomach**—The stomach is more frequently invaded by cancer than any other organ in the body in the male sex, whilst in females it comes next to the breast and uterus in order of frequency. Any and every part of the viscus may be affected, but in 60 per cent of the cases the tumour starts in or about the pylorus, and is of a scirrhus nature. When the cardiac end is attacked, the disease may spread from the œsophagus and is a squamous epithelioma, but when the body of the organ is invaded, the condition is usually a columnar carcinoma.

Cancer occasionally starts at the site of an old ulcer, but there is generally no assignable cause for its onset, except an indefinite

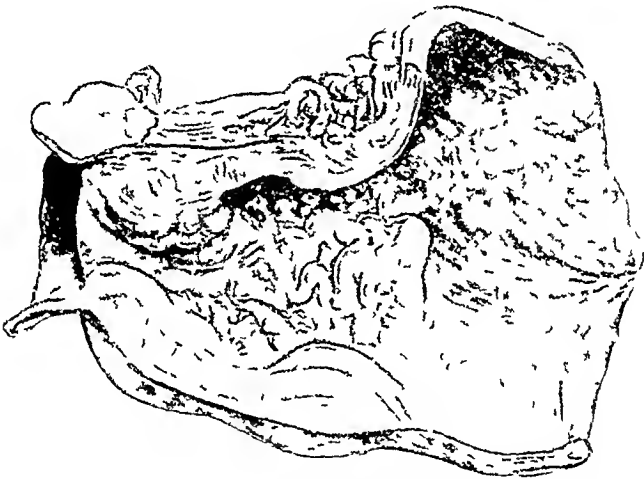


FIG 362 —CANCER OF PYLORIC END OF STOMACH (KING'S COLLEGE HOSPITAL MUSEUM)

The abrupt limitation of the growth at the commencement of the duodenum is well seen

history of injury. It may occur as a nodular outgrowth, perhaps covered with papillomatous projections and early undergoing ulceration, if it is of a hard type, the ulcerated surface has a characteristic everted margin. Sometimes the whole organ becomes infiltrated by a diffuse carcinomatous growth, constituting a firm mass incapable of dilatation or much contraction, which has been aptly termed the 'leather-bottle stomach'. At the pyloric end (Fig 362) the growth is always of a hard nature, and forms an annular constriction, through which it may be difficult to pass even a small catheter, it is sharply limited on its duodenal aspect, but spreads into the body of the organ, and especially towards the lesser curvature, following the main line of the lymphatic stream. The lymphatic glands lying along the lesser curvature are involved, usually extending as far as the point where the coronary artery reaches the stomach, whilst those

along the pyloric end of the great curvature are implicated to a less degree (Fig 368) Thence the affection spreads to the liver and to the coeliac glands, and there may compress the inferior vena cava and thoracic duct Adhesions form around the growth, fixing it to the under surface of the liver, to the head of the pancreas, the colon, and even when of large size to the anterior abdominal wall These adhesions often prepare the way for an extension of the disease to the peritoneum, over which disseminated nodules of cancer may be scattered, often giving rise to a considerable effusion of serous fluid The omentum also becomes infiltrated, and colloid degeneration is not unusual in this region, the omentum being converted into a solid translucent mass, looking sometimes like firm sago pudding

Speaking generally, the malignancy of gastric carcinoma is decidedly less than that of such organs as the breast or uterus, in that secondary glandular affections are later in developing, and even when the nearest group is involved it may be some time before the affection spreads to distant parts

*Clinical Phenomena* — Gastric cancer often begins with certain indefinite symptoms, the significance of which is easily overlooked in the early stages, the case is then often allowed to run on with the idea that it is merely one of 'dyspepsia,' 'internal influenza,' or the like, so that a thorough and exhaustive examination is not made, and the time for radical interference passes without the disease being recognised Pain is often the first symptom, slight at first, but gradually increasing, and referred to the epigastrium or back Food may increase or relieve it, but as time progresses the pain comes on independently of meals Acid eructations and a sense of epigastric oppression soon follow, and these in time give place to actual attacks of vomiting, the ejecta perhaps containing blood, but usually not till late in the case Loss of appetite and steady wasting are also marked features in the early stages The persistence of such a group of symptoms should always lead to a complete investigation of the stomach and its functions (1) The epigastric region is carefully palpated and the nature and position of any unusual swelling noted It may be desirable to inflate the organ with air or gas and ascertain its exact size, by this means it is sometimes possible to detect a tumour which would otherwise escape notice (11) The composition of the gastric juice should be investigated by the use of a test meal and the stomach tube The meal consists of a cup of weak tea without milk and a small slice of toast, it is given on a fasting stomach, and for choice early in the morning, and withdrawn an hour and a quarter later In cancer the amount of HCl is usually diminished, whilst that of lactic acid is increased, the latter is probably a fermentation product This test must be looked on as a valuable, but not as a constant, indication of the presence of cancer HCl is usually increased, and not diminished, in the cancer that supervenes on a chronic ulcer, and we have met with well-marked cases of ordinary cancer where the HCl was normal and lactic acid absent Moreover, HCl is absent in many gastric lesions other than cancer,

and hence this phenomenon must always be considered in conjunction with the other clinical symptoms (iii) The motor power of the viscus is very considerably lessened, so that the passage of its contents into the duodenum is delayed, this is due to a chronic interstitial gastritis (iv) A blood count in carcinoma usually reveals a well-marked secondary anæmia, together with a moderate leucocytosis (v) Microscopic examination of the vomit may also throw light on the case

To these general signs certain special ones may be added, varying with the location of the growth 1 If the *cardiac end* is involved, a tumour can rarely be detected, the stomach being small and contracted The patient complains chiefly of pain on swallowing, and the vomiting occurs immediately after each meal The symptoms are practically those of œsophageal cancer

2 When the *pylorus* is affected, a tumour can often be felt a little above and to the right of the umbilicus, which is at first rounded and definitely limited, except on the left side, where it shelves off into the stomach, it is moveable in the early stages, but later on becomes fixed, it is firm in consistence, and somewhat tender on manipulation and pressure, and may receive pulsation from the underlying aorta Owing to the stenosis of the pylorus, which almost invariably accompanies this condition, the stomach becomes dilated, and its great curvature displaced downwards, perhaps almost into the pelvis In this a large accumulation of fluid takes place, which can be heard splashing about when the patient is moved, every day or two he brings up a large quantity of fluid and decomposing food, covered with a yeast-like scum, and sometimes containing sarcinæ in abundance Hæmatemesis is not uncommon

3 When the *body* of the organ is involved, a tumour may or may not be felt, according to its situation The 'leather-bottle' stomach can be sometimes detected as a solid mass projecting forwards from under the left costal margin The organ is not dilated, and the vomiting has no special characters, hæmatemesis may or may not be present

In the later stages pressure phenomena manifest themselves Ascites may result from compression of the portal vein, jaundice, from implication of the common bile-duct, œdema of the legs and varix of the superficial abdominal veins may arise from pressure upon the inferior vena cava, whilst the peritoneal cavity may be distended with chyle owing to the pressure of lymphatic glands on the receptaculum chyli or thoracic duct All these later signs are indications that the time has passed when radical treatment is possible A similar indication is given by enlargement of a gland in the left supra-clavicular fossa, which sometimes occurs, this results from dissemination of cancer cells up the thoracic duct

**Treatment**—So many cases of this affection reach the surgeon too late that, at the risk of wearying our readers, we would reiterate what has been already stated When the symptoms of chronic gastritis persist in spite of careful dieting and treatment, and the

patient is losing flesh, one should always look on the case with suspicion. Granted that the examination of the gastric juice reveals the characteristic changes referred to above, and still more when a blood count indicates leucocytosis and a diminishing quantity of hæmoglobin, then an exploratory operation is quite justifiable. On the other hand, we would give a word of warning against the common practice of considering that the mere presence of a tumour in the epigastrium warrants an operation. When a well-marked tumour is present, the probability is that the disease has extended beyond the reach of surgery, and therefore, unless there are distinct indications for palliative treatment, *eg*, the signs of pyloric stenosis, the patient is often better left to the care of the physician. Of course, in many cases an operation is undertaken in the almost vain hope of being able to do something to prevent the patient being condemned to certain death, but when ascites, jaundice, or definite evidences of dissemination are present, the surgeon should be very chary of interfering.

For cancer of the cardiac orifice, gastrostomy (p 997) may possibly be desirable, the artificial stoma being placed nearer to the pylorus than usual.

For cancer of the body of the stomach, a partial or total gastrectomy (p 1000) may be feasible in the absence of massive adhesions, but the conditions which permit of such procedures are unusual. If there is any evidence of obstruction to the passage of food, a gastro-enterostomy (p 1001) is undertaken, and, indeed, this operation is always useful in such a case in that it enables the viscus to empty itself more quickly. Owing to the usual location of the carcinoma on the posterior wall, the surgeon may be driven to utilize the anterior operation. Sometimes the disease is so extensive that even this procedure is impracticable, the patient's nutrition is then likely to fail rapidly, and possibly life may be prolonged (if such be desirable) by the formation of an artificial opening into the jejunum (jejunostomy), through which he may be fed without using the stomach.

For cancer of the pylorus, operation is more frequently possible, whilst, even if removal is impracticable, palliative measures to short-circuit the growth may be feasible. If the mass is comparatively moveable, and there are but few adhesions, pylorectomy (p 1000) or removal of the diseased portion of the organ may be undertaken, and even should secondary deposits be present in the liver, the patient is probably better off after such a procedure than if left alone. When the growth is firmly adherent to adjacent viscera, gastro-enterostomy is alone practicable, and will do much good by permitting of the passage of food into the bowel without passing over the ulcerated surface, it will also allow the dilated organ to be more completely and quickly emptied, and consequently fermentation processes are minimized and the patient will suffer less from toxic absorption.

Failing all operative measures, the patient's nutrition must be maintained by such food as causes him the least discomfort, and

considerable relief will be experienced from regular and systematic lavage of the organ. Opium will be needed for pain.

**Simple Stenosis of the Pylorus** results from a number of different conditions, and gives rise to a well-marked group of symptoms. (1) Most frequently it is due to the healing of a gastric ulcer, situated within or close to the pyloric orifice, in the acute form, where the ulcers are small, spasm as a result of the associated hyperchlorhydria is an important element in aggravating the symptoms caused by a slight contraction. (2) It may result from the contraction of extrinsic adhesions. These may be massive or bandlike, in the former case the pylorus is imbedded in the newly-formed fibrous tissue, in the latter it is kinked, and subsequently contracted. Such adhesions may be secondary to gastric ulcer, or may spread from an inflamed gall-bladder (peri-cholecystitis). (3) It is occasionally met with as a *congenital hypertrophy* of the pylorus, in which the overgrowth chiefly involves the muscular fibres. This manifests its presence in otherwise healthy children within a few weeks or months of birth by persistent vomiting immediately after food, unattended by pain or retching, and necessarily resulting in a steady loss of nutrition. The stomach becomes enlarged after a time, as in the other varieties, and the pylorus can sometimes be palpated as a moveable tumour.

The physical results of pyloric stenosis consist in hypertrophy and dilatation of the stomach, which becomes enlarged downwards, and forms a sac, in which food collects perhaps for days, and undergoes fermentative changes, being finally ejected in large quantities, mixed with frothy mucus and a yeast-like scum containing an abundance of sarcinæ. The stomach may in time almost reach the pelvis, the pylorus being dragged down with it. Succussion or splashing sounds are heard on shaking the patient's abdomen, and peristaltic waves may be elicited on tapping it sharply.

The **Treatment** consists at first in washing out the stomach regularly, but when that fails to give relief one of the following proceedings may be undertaken. (a) *Loiret's Operation* consists in dilating the stenosed orifice with the finger. The viscus is opened midway between the curvatures and about 2 inches from the pylorus, and first one finger is introduced, slowly and carefully, then two, and even perhaps three, no violence is admissible, or the walls of the orifice may be torn or ruptured. The results of this procedure are temporarily satisfactory, but it is now being replaced by more certain methods which are less likely to be followed by recurrence of symptoms. (b) *Excision of the Pylorus* has been undertaken in some cases, but is rarely available. The condition has usually gone on so long before operation is considered that the stomach is dilated and atonic, and even if the obstruction is removed food may collect and decompose in the pouch formed by the dilated organ. (c) *Pyloroplasty* (p. 1001) is useful in similar cases where the stricture is free from adhesions, and where it is narrow and annular, but will be useless in conditions similar to those under which pylorotomy is indicated. (d) *Gastro-enterostomy* is usually the operation of choice, inasmuch as it provides



more efficient drainage of the dilated stomach than any other proceeding. The mortality is small, and the results most gratifying.

**Acute Dilatation of the Stomach\*** is a curious condition occasionally met with in surgical practice, as an unexpected and unwelcome sequela of injury or operation, and that by no means necessarily limited to the abdomen. It is rather more common in medical work, arising either without apparent cause, or in the course of debilitating illnesses. It is characterized by a sudden onset, the vomiting of enormous quantities of fluid, and severe general symptoms, which usually terminate fatally in a few days. The stomach becomes enormously dilated, even sagging down into the pelvis, and the walls are more or less paralyzed, as peristalsis is rarely evident. The pathology of this condition is uncertain, but it is possibly due to constriction of the third piece of the duodenum by the root of the mesentery through a downward drag of the intestines. **Treatment** consists in regular lavage, and in some cases the abdominal decubitus has given relief, rectal alimentation is required. Surgical treatment is very unlikely to do good, unless there be some associated obstruction near the pylorus.

### Operations upon the Stomach

1 **Washing out the Stomach** is needed in cases of poisoning, in chronic catarrh, in dilatation of the organ, and as a preliminary to operations in which its cavity is to be laid open. It may be accomplished by the ordinary stomach-pump, or by the simpler method of passing a long tube of good-sized calibre, to the upper end of which is attached a funnel. Fluid is introduced through the funnel, and syphoned out by lowering it below the level of the stomach. Before open operations, a warm solution of boric acid should be employed as the agent for irrigating the viscus.

2 **Gastrotomy**, or opening the stomach, is required for the removal of foreign bodies from it or from the lower end of the œsophagus, for exploratory purposes, and as a means of dilating simple strictures of either the pyloric or cardiac orifices (Loreta's operation).

**Operation**—<sup>1</sup> Made in the middle line above the umbilicus, unless special indication to the contrary.

The peritoneum is opened, and the stomach recognised by its position immediately under the liver, and by the thickness, pink colour, and opacity of its walls. If the omentum or transverse colon presents in the wound, it must be pushed down, and the stomach looked for above. The spot where the stomach is to be opened is now selected, and the part drawn out and carefully packed around with sterilized gauze so as to prevent contamination of the general peritoneal cavity. The incision is made in the long axis of the stomach, and the finger inserted. The removal of a foreign body must be undertaken with great care, so as not to inflict injury on the organ, the wound being enlarged, if necessary. The stomach is subsequently closed by the

\* For further details, see 'Acute Dilatation of the Stomach,' by H. Campbell Thomson, M.D. Baillière, Tindall and Cox, 1902.

Czerny-Lembert suture, and replaced, all traces of blood, etc., are removed, and the external wound is closed in the usual way

The *cardiac orifice* is not easily reached, as it lies deeply just in front of the aortic opening in the diaphragm. It can be dilated by the fingers or by suitable dilators, and a foreign body by this means removed from the lower end of the œsophagus. The utmost gentleness must be observed in this proceeding, as serious symptoms may be caused by irritation or injury of the *pneumogastric nerves*, the terminations of which pass through this opening in the diaphragm.

The operations on the *pyloric orifice* are dealt with below

✓ 3 **Gastrostomy** consists in the formation of a permanent artificial opening into the stomach, through which the patient can be fed. It is needed in cases of malignant disease or intractable stenosis of the œsophagus, where the patient is exposed to the risk of starvation, owing to his inability to take nourishment.

During the last few years a number of excellent operations have been introduced, whereby this end is secured without the resulting escape of gastric juice, followed by irritation and digestion of the surrounding skin, which were so constantly seen in the old days. Most of them depend on the formation of a muscular valve or sphincter, and there can be no doubt that the improvements thus effected have been very great. Two chief methods have been suggested

—viz, Witzel's and Frank's, the latter of these is, to our minds, the preferable, and the results gained thereby are so satisfactory as to warrant us in describing it in detail.

1 **Frank's Operation**—Fenger's oblique incision (Fig 363, A) for exposure of the stomach is first made, the viscus withdrawn and examined, and a silk shing passed through the serous and muscular coats at the site selected for the artificial opening, so that a cone-shaped portion of the wall can be drawn up into the wound. The parietal-peritoneum is then sutured all round to the base of the cone, so as to shut it off from the general serous cavity. A second incision (A<sup>1</sup>), about 1 inch in length, is now made on the outer side of

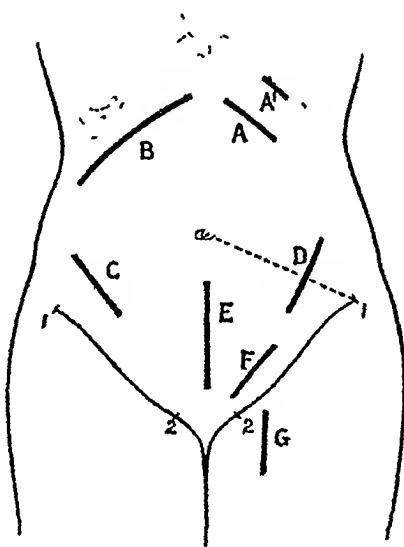


FIG 363 —INCISIONS UTILIZED IN VARIOUS ABDOMINAL OPERATIONS

A, Fenger's incision for exposing the stomach, A<sup>1</sup>, additional incision in Frank's gastrostomy, B, incision for exposing the gall bladder, C, incision for operations on appendix, D, left iliac colotomy, E, median incision for ovariectomy or supra pubic cystotomy, F for radical cure of inguinal hernia or varicocele, G for femoral hernia, 1, anterior superior iliac spine, 2, pubic spine

the first wound, parallel to it, and about  $1\frac{1}{2}$  inches from it. The bridge of skin and subcutaneous tissue between the two is separated from the subjacent structures, and the apex of the cone of gastric wall drawn under the bridge into the second wound. A small opening is then made into the viscus through the apex, in which the silk sling is located, and the mucous membrane stitched accurately to the skin in the centre of the incision. The remainder of this incision is then closed in the ordinary way, as also the first. Healing readily occurs, and thus a valvular opening is established, which passes in an angular fashion round the margin of the costal cartilages, tending to prevent

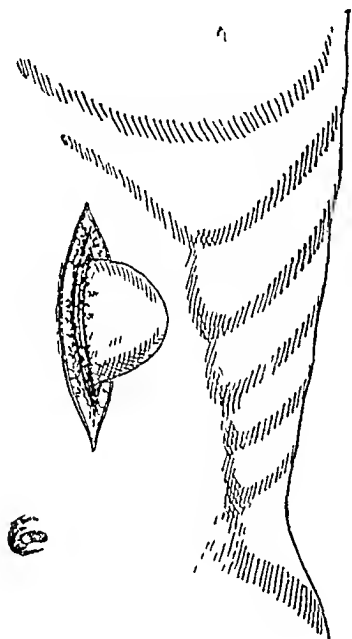


FIG 364

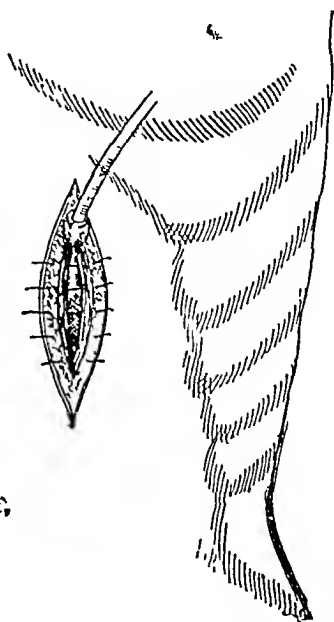


FIG 365

FIGS 364 AND 365 —GASTROSTOMY (FRANK'S MODIFIED OPERATION)

In Fig 364 the base of the cone is seen sutured to the peritoneum and sheath of the rectus, in Fig 365 the stomach has been opened, a tube stitched in, and the sutures passed through the rectus are in place

regurgitation of the gastric contents. The patient may be fed by the artificial opening at once.

We have somewhat modified this operation of late, and the results have been still better than when we utilized Frank's original method. Instead of the oblique incision, a vertical one (as suggested by Kocher) is employed, extending for 3 or 4 inches downwards from the eighth costal cartilage and passing through the substance of the rectus muscle (Fig 364), which is split by the fingers or handle of the knife into two portions. A cone-shaped portion of the stomach wall is withdrawn, and its base stitched to the parietal peritoneum and posterior layer of the sheath of the rectus. A small hole is made in

the apex of the cone, and through this is passed a piece of rubber drainage-tube, free from lateral openings, and about the size of a No 10 catheter, exactly fitting the opening in the stomach, it should project  $1\frac{1}{2}$  inches inside the cavity, and about 6 inches of it should remain outside (Fig 365) This is stitched firmly to the stomach wall, and the apex of the cone is then drawn to the upper angle of the incision. The halves of the rectus muscle are freed from the posterior layer of the sheath and drawn together by sutures, so as to cover in all the exposed gastric wall except the apex of the cone,

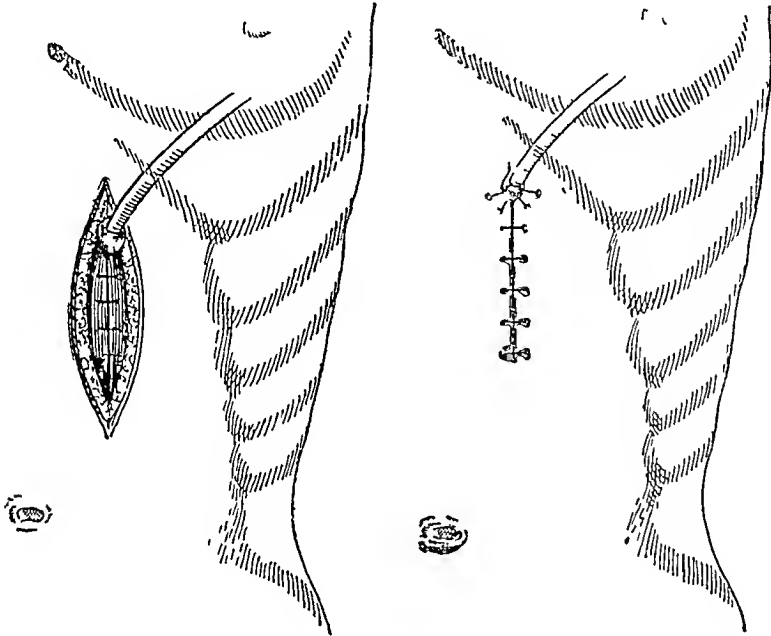


FIG 366

FIG 367

FIGS 366 AND 367 —GASTROSTOMY (FRANK'S OPERATION MODIFIED)

In Fig 366 the sutures in the rectus have been tied, and only a small portion of the stomach projects in Fig 367 the operation is completed

which with the tube forms a nipple-like projection, around which the muscle fits like a sphincter (Fig 366) The incision in the skin is then closed, and finally the serous and muscular coats of the projecting portion are carefully stitched to the skin. The results of this procedure have been most satisfactory, many cases having run their course without a drop of gastric juice escaping. The amount of food at first administered is small, and rectal feeding may be required in addition, but it is gradually increased until perhaps 17 ounces can be retained four times a day. The patient should be kept in the recumbent posture for three weeks.

\* For further details see *Carless* 'On Gastrostomy, King's College Hospital Reports, vol 1, 1897-1898, and in *Edinburgh Medical Journal*, July, 1902

*Witzel's Operation*—This consists in making a valvular opening into the stomach by introducing and stitching a tube into it as in the last proceeding, and then burying the projecting portion as far as possible by suturing the serous and muscular coats together over it. The stomach is then fixed to the abdominal parietes and the skin closed. The functional result of this operation is very good, but the fixation to the abdominal wall is not so secure as in the former plans.

4 **Gastrectomy**—A good many cases have now been reported in which a limited portion of the gastric wall has been removed success-

fully, either for simple or malignant ulcers or growths. Incisions are made so as to include the mass, and the wound is subsequently closed by Czerny-Lembert sutures.

Total excision of the stomach is a proceeding which has only recently been attempted, but several successful cases are now on record. It has been undertaken for extensive malignant disease, which, however, has left enough of the oesophageal end free to allow of its apposition and fixation either to the upper end of the duodenum, or, if that cannot be brought across to it, to a suitable coil of the jejunum.

The actual union has been effected either by simple suturing or by introducing a Murphy button.

5 **Pylorectomy**, or partial gastrectomy, for malignant disease of the pyloric end of the stomach, has been associated until quite recently with so great a mortality as to render it almost a hopeless proceeding. Thus, in seventy-two cases dealt with for malignant disease, reported some years back, fifty-five died from the immediate effects. Modern statistics are very greatly improved, and granting that there are not too many adhesions, and that the patient's strength is reasonably good, the operation may be undertaken without much fear.

*Operation*—The abdomen is opened by a median incision, which extends nearly from the xiphoid cartilage to the umbilicus. The diseased area is explored, and a final decision made as to the practicability or not of removing it. If an operation is determined on, the growth is carefully isolated from surrounding parts by dividing the attachments of the great and lesser omenta, any enlarged glands being also included in the scope of the operation. Clamps are then applied to the stomach and duodenum, and the surrounding part of the abdomen carefully protected with sterilized gauze. The mass is now removed (Fig 368), the incisions being so placed as to extend beyond the pylorus about  $\frac{3}{4}$  inch into the duodenum on the one side,

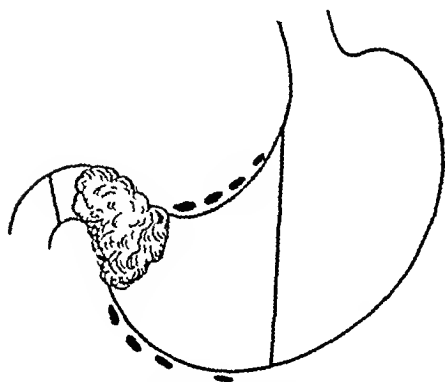


FIG 368 — CANCER OF PYLORUS, INDICATING THE SITUATION OF THE LYMPHATIC GLANDS ALONG THE TWO CURVATURES, AND OF THE INCISIONS NEEDED TO INCLUDE THEM

and on the other so as to remove the greater portion of the lesser curvature, thereby including the lymphatic glands. Bleeding points are secured, and the two incisions completely closed, no attempt being made to appose or unite them. The first part of the jejunum is then drawn up, and an ordinary posterior gastro-enterostomy performed.

The chief danger of the operation is shock, but if this can be avoided by careful protection of the viscera, by the prevention of hæmorrhage, and by rapidity of execution, a good result may be expected. The patient is fed *per rectum* for the first forty-eight hours, if possible, but after that interval small quantities of fluid may be allowed, and the dietary gradually increased.

Pylorectomy for *simple stenosis* is quite a different matter, the pylorus alone needs to be removed, and there should be no difficulty in performing an end-to-end anastomosis similar to that recommended for intestinal lesions (*q v*).

6 **Pyloroplasty** consists in incising the pylorus and reclosing the incision in such a way as to increase the calibre of the tube. It is



FIG 369 —PYLOROPLASTY

The contracted bowel is divided longitudinally, and the aperture thus made opened out, so that it can be brought together transversely

performed for various types of stricture. The operation commences by exposing the pylorus and clearing it from adhesions. A longitudinal incision is then made through the stricture, and by a little careful manipulation this wound can be opened out and brought together in a transverse manner so as to greatly increase the lumen of the orifice (Fig 369). Two rows of stitches are inserted, one through the mucous membrane, and the other through the muscular and serous coats.

7 **Gastro-enterostomy**, or, more correctly, **gastro-jejunostomy**, is constantly resorted to in the treatment of gastric, pyloric, or duodenal lesions. Not long ago the mortality associated with this operation was so serious that it was looked on as a formidable undertaking, in careful and skilful hands the death-rate is now so small (well under 10 per cent) that it is frequently employed. *Indications*—1 For obstruction to the onward course of the food, whether in the stomach, pylorus, or duodenum, and whether simple or malignant in origin. 2 For stasis of the gastric contents (*æc*, retention in the stomach for an undue period—say, over eight hours), whether due to atony of the viscus or following on obstruction. 3 For persistent phenomena of ulceration, either of stomach or duodenum, in spite of suitable treatment. 4 For recurrent hæmorrhage under similar conditions, in order to put the parts at rest by rapidly emptying the stomach, or by

diverting the food from the duodenum 5 As a part of the modern operation of pylorotomy or gastrectomy

The operation consists in the formation of an artificial communication between the stomach and intestine It is important that the selected portion of bowel should be the upper part of the jejunum, since, if the communication is established too low, a much greater absorbing surface is isolated, with the result that, even if the operation is successful, the patient gradually loses ground owing to lack of nutriment, and the rapidity of the emaciation will increase as the communication is placed further from the duodenum

*Operation* —The patient is generally prepared by washing out the stomach for a few days with some mild antiseptic, but this must be done very cautiously, if at all, when ulcers are present The incision employed is usually one in the middle line through the linea alba The stomach is readily found, and the condition of the viscera examined so as to confirm the necessity for the operation Formerly

it was the practice to unite the bowel to the *anterior* wall of the stomach (Fig 370), but there are two obvious objections to this method (a) The jejunum is drawn up over the transverse colon, and is likely to constrict it and lead to obstruction, this is most likely to occur when the opening in the jejunum is as near as possible to the duodenum, a desirable arrangement from many points of view, and (b) the necessary drag of the gut is apt to bring the two ends parallel to each other, and thus produce a spur or kink, by means of which the bile is directed into the stomach instead of into the

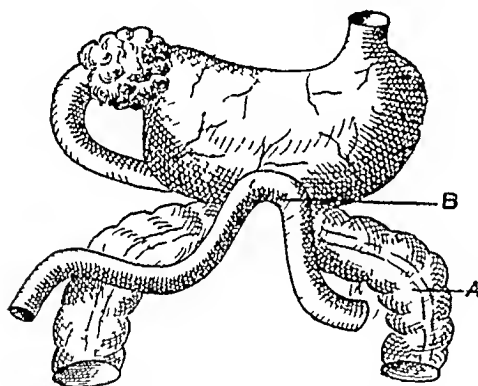


FIG 370 —ANTERIOR GASTRO ENTEROTOMY

A, Transverse colon, B, jejunum dragged up over the colon and omentum (purposely omitted) to be brought into apposition with the stomach

effluent limb, thus establishing a vicious circle Severe bilious vomiting results, which may prove fatal

Hence the majority of surgeons nowadays utilize with advantage Von Hacker's *posterior* operation The transverse colon is withdrawn from the wound, together with part of the omentum By tracing down the transverse meso-colon to its attachment to the posterior abdominal parietes, the termination of the duodenum is reached as it crosses the middle line along the lower border of the pancreas, and with the superior mesenteric vessels lying in front of it, by this means the upper portion of the jejunum is easily found, and a suitable spot for making the anastomosis selected It must be turned over, if need be, and placed so that the peristaltic wave may pass directly from

stomach to intestine, and not be reversed at the site of union. A hole is then made through the transverse meso-colon (Fig 371), so as to open into the lesser sac of the peritoneum, and enable the posterior wall of the stomach to be reached, the margins of this opening are stitched to the posterior gastric wall. A clamp is placed on either side of the selected portion of bowel, so as to prevent the escape of intestinal contents when the gut is opened, but, of course, it is impossible to do the same to the stomach, the latter viscus ought, therefore, to be thoroughly washed out with some dilute antiseptic, such as boric acid, before the operation commences. Moreover, it is pushed forwards from behind by the assistant's hand

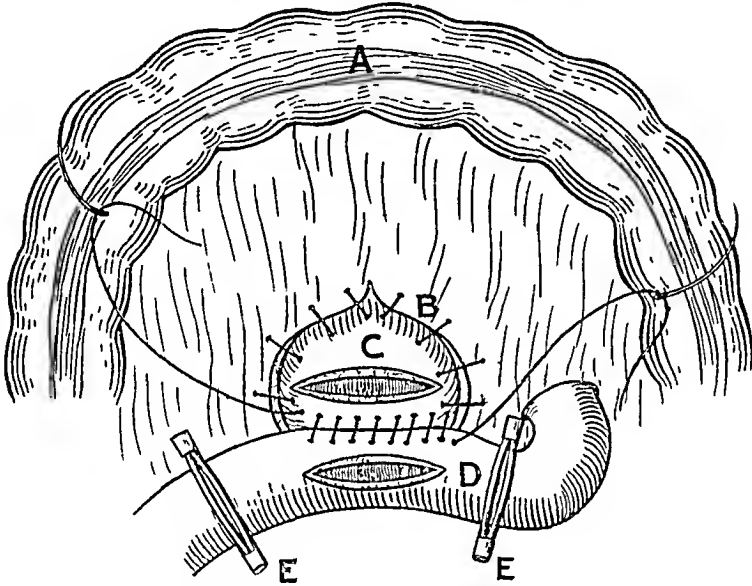


FIG 371 —POSTERIOR GASTRO-ENTEROSTOMY

A, Transverse colon thrown upwards exposing the transverse meso colon, through an opening in which (B) the posterior wall of the stomach (C) is exposed. The margins of the opening are sutured to the gastric wall. D, the upper end of the jejunum with clamps (E, E) in position above and below the opening which is to be sutured to the opening in the stomach. The first sero muscular stitch has secured the bowel and stomach in apposition.

in such a way that the opening is placed above the level of the rest of the viscus in the recumbent position of the patient, and there is therefore but little likelihood of leakage. Sterilized gauze strips are also packed around the site of operation, so as to receive any fluid which may escape.

The actual method of anastomosis usually employed at the present day consists in simple-suturing the parts together without the aid of any mechanical contrivance. To this end two sutures only need be employed, one to unite the mucous membranes, the other for the sero-muscular coats. They may consist of silk or firm catgut,



carefully sterilized, they must be of sufficient length, and are advisably threaded to curved needles at each end

Before opening the viscera the sero-muscular coats are sutured together to an extent a little greater than the proposed length of the incisions (as in Fig 371) Spencer Wells forceps are then attached to the threads at each end, and they are laid aside till further needed A longitudinal incision is made into each viscus, about  $1\frac{1}{2}$  inches long, and about  $\frac{1}{4}$  inch in front of the line of suture Bleeding points are secured, and fluid which might escape mopped up on strips of gauze which are thrown aside The second suture is now utilized to stitch the jejunal to the gastric mucous membrane all the way round the opening, of course, as the anterior parts of the incisions are reached, the assistant must press the viscera forward, so as to approximate them The ends of this inner suture are knotted together Finally, the loose ends of the outer sero-muscular suture are again taken up, and the anastomosis is completed by carrying it all the way round about  $\frac{1}{4}$  inch from the margin of the incision, the two ends are tied together This process of suturing is eminently simple, and after a little practice the surgeon can effect it in very few minutes, the bond of union is safe and reliable

The usual peritoneal toilette follows blood is sponged away, swabs and strips of gauze are removed and counted, the viscera replaced, and the abdominal incision closed

If any mechanical appliance is to be employed in this operation, we would advise the use of Robson's bobbín (p 1027), it is laid in position during the introduction of the inner suture for the mucous membrane, and gives a basis of support over which the two continuous sutures can be tied more firmly It is also claimed that the line of junction is protected by its use, as by an internal splint To our minds the results of simple suturing without it are so excellent that its employment is a needless refinement

A few surgeons still recommend the use of Murphy's button (p 1028), it is introduced according to the rules given for a lateral anastomosis We consider that its employment in this connection is quite unjustifiable, except under the most unusual circumstances

The *after-treatment* consists in abstaining from stomach-feeding for at least forty-eight hours, if practicable, rectal alimentation being resorted to in the interval Not unfrequently there will be some regurgitation of bile into the stomach, and this may lead to troublesome vomiting for a few days, but if the junction is satisfactory, it soon passes off, especially when food is administered by the mouth, as may usually be undertaken on the third day At first only fluid nourishment should be permitted, but in a week's time soft solids may be given, and gradually a more liberal diet is ordered The effect of the operation is necessarily only palliative when cancer is present, but the general condition often improves considerably for a time, and the final exitus letalis is associated with less suffering

Various suggestions have been made in order to minimize the risks of serious bilious vomiting 1 It may usually be prevented by

making the opening in the jejunum as near the duodeno-jejunal junction as possible, the formation of a kink is thereby hindered 2 A second opening is sometimes established between the afferent and efferent coils 3 The jejunum is cut across, and a Y-anastomosis made (Roux), the lower segment being implanted at right angles into the stomach wall, and the upper or duodenal end into a second opening in the gut lower down We doubt whether the two latter suggestions are justifiable, they can always be resorted to should the vicious circle of biliary regurgitation develop

**Ulcers of the Duodenum** are very similar in nature and origin to those of the stomach They occur most frequently in men thirty to forty years of age, and often without any obvious cause Oral sepsis is not uncommonly present, as also hyperchlorhydria, in some cases chronic nephritis has existed, and in others the lesion follows some operation The ulceration which forms a very occasional sequela of burns has been already alluded to (p 113) The upper part of the duodenum is that usually affected, well above the entrance of the bile-duct, the character of the ulcer is similar to that seen in the stomach

The **Symptoms** are often very uncertain if no complications are present Pain may be noticed in the right hypochondrium, sometimes, but by no means invariably, referred to the back When characteristic, it appears some little time after the ingestion of food, viz, two to four hours, vomiting is not a very frequent symptom, but when present it may relieve the pain The ejecta may contain a certain proportion of bile—Hæmorrhage is another important sign, the blood being mixed with the vomit, or passing down the bowel and escaping with the motions (melæna) In a considerable percentage of cases, however, the condition is absolutely latent and free from symptoms until acute manifestations of perforation or hæmorrhage supervene

**Perforation** usually involves the first part of the duodenum, and may be intra- or retro-peritoneal The conditions produced are practically identical with those following a perforated gastric ulcer, but with slight differences due to the change of situation Thus, with the usual acute intra-peritoneal perforation the fluid on escaping from the duodenum is guided downwards by the ascending meso-colon to the right iliac fossa, and hence the symptoms of acute appendicitis are somewhat simulated, but it may be possible to locate the primary pain to the hypochondrium The mischief soon spreads, however, to the general cavity, and the localizing symptoms disappear The effusion includes the fluid duodenal contents, often very abundant and perhaps bile-stained, and usually free gas If the opening in the duodenum is small and the contents escape slowly, a subphrenic or subhepatic abscess may form, but the adhesions are not very firm, and it may burst secondarily into the general serous cavity A retro-peritoneal perforation of the duodenum is the origin of a subacute subphrenic abscess, which is placed behind the peritoneal cavity, but always to the right side of the falciform ligament

*Hæmorrhage* of an alarming and fatal character is sometimes the first sign of duodenal ulceration. In these acute cases it arises from erosion of some branch of the pancreatico-duodenal vessels. Less serious but somewhat persistent hæmorrhage is sometimes observed.

*Stenosis* of the duodenum may result from the cicatrization of ulcers, and may lead to frequently-repeated vomiting, dyspepsia of an intractable type, a greatly-distended stomach, and emaciation to an alarming degree.

**Treatment**—If a diagnosis can be made and no complications are present, the same treatment is instituted as for gastric ulcer, viz, rest in bed and rectal alimentation. Persistence of symptoms, *e.g.*, vomiting, hæmorrhage, etc., is treated by gastro-jejunostomy, and the results are most satisfactory. Perforation, of course, needs immediate operation, as described for the stomach (p 988). In the earlier stages of a duodenal perforation, the incision will probably be located along the right semilunar line for 4 or 6 inches. The opening, when found, should be stitched up in the transverse axis of the bowel, so as not to diminish its calibre. Stenosis of the duodenum is treated most successfully by gastro-enterostomy, and there are few operations in surgery which give more gratifying results.

### Affections of the Intestine

**Congenital Conditions** are occasionally met with affecting the intestines, and perhaps giving rise to serious complications. (*a*) The most common of these consists in what is known as *Meckel's diverticulum*. It occurs as an outgrowth from the lower end of the ileum, which may be patent for 1 or 2 inches, terminating possibly in a fibrous cord, which floats free amongst the intestines, or may contract adhesions, and thus determine an internal strangulation, sometimes it persists as an open tube as far as the umbilicus, giving rise to a congenital fæcal fistula. It is due to non-obliteration of the omphalo-mesenteric duct. (*b*) *Congenital stenosis* of the duodenum also occurs opposite the entrance to the common bile duct, and a similar condition may arise in the lower part of the ileum at a spot corresponding to the site of Meckel's diverticulum.

**Contusion of the Intestine** may result from any serious blow on the abdomen, and necessarily varies in its effects with the nature and force of the injury, the amount of distension of the gut, and the strength and power of resistance of the parietes. In its simplest form, it merely produces a little bruising of the intestinal wall, followed by a subacute or chronic enteritis, from which with care the patient quickly recovers. In the more severe cases, an acute enteritis ensues, due to bacillary invasion, which may even run on to ulceration or sloughing of the coats of the bowel. The latter result is more likely to follow if the mesentery has also been involved in the injury so as to produce thrombosis of the mesenteric vessels. Under these circumstances, the final issue depends largely upon the rapidity of the inflam-

matory process If adhesions have had time to form between the parietes and the injured gut, the mischief is limited, and the patient may recover with an artificial anus or fæcal fistula, the formation of which has been preceded by a localized intra-peritoneal abscess, containing extremely offensive pus, owing to the presence of the *B. coli*, which has migrated through the intestinal wall If, however, the inflammatory affection is rapid in its onset, and adhesions have not had time to develop, acute diffuse peritonitis is almost certain to follow When the injured portion of the bowel is retro-peritoneal, as in the duodenum or colon, a retro-peritoneal abscess may form

The **Symptoms** of intestinal contusion consist primarily of shock and pain The amount of shock varies necessarily with the severity of the injury and the nervous susceptibility of the patient The pain may not be severe during the period of shock, but is always very marked subsequently, and increased by examination, movement, or during violent respiratory efforts To limit such movement, the abdominal parietes are maintained in a state of firm contraction, and can be felt hard and resistant Vomiting may be present, but is not a marked feature The later symptoms necessarily vary with the course taken by the case, and need not be described in further detail

**Treatment** is conducted along the same lines as that of contusions of the abdominal wall (p 970), viz, where there is no absolute evidence of rupture, an expectant attitude must be adopted, but the surgeon must be ready to interfere should any grave or suspicious symptoms arise Acute enteritis induces diarrhœa and the passage of blood-stained mucus, and such symptoms will indicate the use of bismuth, and perhaps a little morphia, whilst a fluid diet or rectal feeding is alone permissible

**Rupture of the Intestine** follows abdominal injuries of a more severe character than those causing contusion, such as when a cart or cab has traversed the abdomen, or when the patient has been tightly squeezed A distended coil is much more likely to give way than one that is empty, in the latter case it is quite possible for a small wound to occur, through which the intestinal contents are unable to escape, owing to the opening becoming blocked by eversion of the mucous membrane, or being covered over externally by omentum which becomes adherent The bowel does not always give way at the point of impact, but occasionally at a distance from it, under these circumstances the tear is more likely to be ragged and irregular, whilst if it yields at the point struck, the gut may be cleanly torn across The parts most frequently affected by this form of injury are the junction of the moveable jejunum with the fixed duodenum, and the lower 3 feet of the ileum The fluidity of the contents of the small intestine has a grave prognostic significance, since they become diffused so readily The effect of the accident on the mesentery is also of importance, since in the first place it may give rise to considerable intra-peritoneal hæmorrhage, and later on may cause sloughing of the gut as a result of thrombosis

The early **Symptoms** consist of severe and usually lasting shock,

accompanied by intense abdominal pain. Owing to escape of the intestinal contents, a virulent form of acute peritonitis follows immediately, from which the patient rapidly succumbs. Free gas is sometimes, but not frequently, present in the peritoneal cavity, as in rupture of the stomach. In a few cases emphysema of the abdominal walls has been caused, and ~~in the absence of thoracic injuries or of diffuse cellulitis is an absolutely certain sign of rupture of the intestinal tube.~~ Vomiting occurs, but not to an excessive degree; if blood is found in the vomit, it suggests that either the stomach or upper part of the intestinal canal has been injured. Occasionally a blood-stained motion is passed, but only late in the case.

The **Diagnosis** of a ruptured intestine is always a matter of uncertainty in the absence of emphysema of the abdominal walls, which is very uncommon. Formerly it was supposed that free air or gas in the peritoneal cavity would be certain to find its way up between the liver and the abdominal wall, hence loss of the liver dulness was considered an important sign. It is by no means certain, however, that the gas does travel in this direction, and a resonant note over the liver is a common result of distension of the colon. If, however, the abdominal wall is retracted and not distended, the existence of this sign is suggestive. The amount of shock is also an uncertain guide, as it varies both in degree and duration. The temperature does not help much, although a secondary fall below normal after reaction, especially if associated with increasing rapidity of pulse and respiration, is very suggestive of grave mischief. The presence of an area of deep fixed tenderness and pain with, perhaps, a rigid abdominal wall over it, and the incidence of early acute peritonitis, are probably the only signs that we can depend upon with any certainty. The history and nature of the accident are important, and should be carefully investigated.

In the non-existence of any distinct signs of rupture, **Treatment** in the early stages can only be expectant, and directed towards combating the shock and relieving the pain. A small dose of opium should be administered with this object, and also to check peristalsis and hinder further extravasation of the intestinal contents, but as little as possible should be given, since it tends to mask symptoms. If the surgeon has good grounds for suspecting that the intestine is torn, he ought at once to undertake an exploratory laparotomy, which in careful hands will do less harm to the patient than waiting for the onset of acute peritonitis to make the diagnosis certain. If severe shock is present, an injection of hot saline solution into a vein will sufficiently restore the patient in the majority of cases to warrant such a procedure. When a rupture is found, the same rules of treatment should be followed as those which have been enunciated for a ruptured stomach.

**Punctures or Stabs** involving the intestine lead to a similar series of phenomena, but the diagnosis may be easier, as gas or fæcal material may escape through the external wound. The direction of the incision in the gut is of importance, since a longitudinal cut (running

parallel to the axis of the bowel) is more likely to gape than a transverse one, owing to the greater power of the circular muscle fibres, a small puncture may be almost closed by a protrusion of mucous membrane. Shock is not necessarily so severe as when the intestine is ruptured by violence without penetration, abdominal pain is always present, and the phenomena of acute peritonitis quickly follow.

**Treatment**—Every case of suspected penetration should be carefully explored. The skin and superficial parts of the wound are first thoroughly purified, and then the wound is laid open and the deeper parts examined. If the peritoneum is not opened, the different layers of the wall are sutured together. If the peritoneum has been involved, the opening in it should be enlarged, so as to explore the viscera and determine with certainty whether or not the gut has been wounded. If a small punctured or incised wound of the intestine is present, it is closed by a purse-string stitch or by a row of Czerny-Lembert sutures. If a more extensive lesion exists, excision of the damaged portion may be necessary, but if the patient is deeply collapsed from the supervention of peritonitis, it may be wiser to bring the divided ends to the abdominal wall, and form a temporary artificial anus, which is subsequently dealt with when the patient's general condition has improved. As to the treatment of the resulting peritonitis, we must refer to what has been written concerning rupture of the stomach (p. 988).

For **Gunshot Wounds** and their treatment, see pp. 240 and 241.

**Perforation of the Intestine** arises from many different causes, such as the impaction of a foreign body, or the yielding of an intestinal ulcer, as occurs in tuberculous disease or typhoid fever, or from that form of enteritis which follows strangulated hernia. We have already discussed the phenomena resulting from the perforation of an ulcer of the stomach or duodenum (pp. 987 and 1005), and another variety caused by perforation of the appendix will be alluded to subsequently (p. 1039).

When the jejunum or upper portion of the ileum is involved, perforation is usually due to the impaction of a foreign body, such as a fish-bone, or to yielding of a tuberculous ulcer. In acute cases, general peritonitis is almost certain to follow, and what we have written as to the results and treatment of such a lesion in the stomach applies here with equal force. Occasionally the lesion is of a more chronic type, especially when due to tubercle, and then adhesions may form, allowing an intra-peritoneal abscess to develop, and should it open externally, a faecal fistula follows. In not a few cases the process of cicatrization may lead to a spontaneous closure of the fistula, and no operation should be undertaken until sufficient time has elapsed to determine whether or not this will occur. A similar condition sometimes results from tuberculous peritonitis, the umbilicus being a common site for such a fistula to develop. In other cases several coils of intestine may be matted together by adhesions, amongst which an abscess forms, and this, by opening into the bowel in two or more places, gives rise to a fistulous communication, known as a *fistula bimucosa*.

In the lower portion of the ileum, *typhoid fever* is the most usual cause of perforation. It generally occurs about the end of the second or in the third week of the disease, and rarely more than one perforation is present. It is most commonly seen in bad cases associated with meteorism and hæmorrhage, but is not limited to such. The symptoms are usually those of sudden collapse, as indicated by a falling temperature and a quick and feeble pulse, whilst severe and persistent abdominal pain followed by distension indicates the development of general peritonitis. Even when the patient is already collapsed by the disease, some slight fall of temperature with acceleration of the pulse may occur, followed by abdominal pain and meteorism. Early rigidity of the belly wall is an important diagnostic sign, whilst there may be some irritability of the bladder. The only *treatment* which holds out any prospect of saving the patient is operation, but owing to his depressed condition the outlook is not particularly bright. Obviously, when he is moribund, it is useless to interfere, but the facts that of some 300 cases operated on and reported 27 per cent. have recovered, and that the death-rate has gradually fallen from 90 to 69 per cent., indicate that in cases diagnosed early a fair proportion of success may be anticipated. The abdomen should be opened in the middle line below the umbilicus, or directly into the right iliac fossa, and if the lesion is not at once obvious, the ileum is sought for at its junction with the cæcum, and the bowel brought up and carefully examined inch by inch till the perforation is found, it may then either be closed by sutures introduced so as to close the wound in the transverse axis of the gut and thus diminish the risks of a subsequent stenosis, or the edges of the ulcers stitched to the margins of the wound so as to create a temporary artificial anus. The peritoneum is cleansed and drained in the usual way, after determining that no second perforation is present or imminent.

In the large intestine the most common cause of perforation is ulceration due to chronic obstruction. Masses of fæces accumulate within the bowel, and by their pressure give rise to inflammation of the walls, which runs on either to ulceration or to actual necrosis. Most usually the peritoneum is by this means laid open, and acute perforative peritonitis follows. In malignant disease of the colon, perforation also occurs in some instances, giving rise to a localized abscess, and subsequently to a fæcal fistula.

**Foreign Bodies** in the intestine are of three types

1. *Gallstones* give rise to no symptoms unless they are of large size, the smaller ones enter the canal through the common bile-duct after an attack of biliary colic, and are voided in the stools. Larger stones usually gain entrance to the intestine by ulceration from the gall-bladder into the duodenum. A coating of fæcal material is likely to form around them, and thus they increase in size as they pass downwards, whilst the intestine gradually diminishes in calibre from the duodenum to the ileum, so that they are likely to become impacted in the lower ileum. Women over fifty are most often the

subjects of this condition, and there may be only a history of some inflammatory condition in the region of the gall-bladder, and none of biliary colic

2 *Enteroliths* are of three classes (a) Calculi of phosphate of lime or inspissated fæces form around some foreign body as a nucleus (b) Masses of indigestible vegetable material may be matted together with inspissated fæces, mucus, etc., they are said to be not uncommon in Scotland (the so-called *avenolith*), consisting largely of the husks of coarse oatmeal They have also been known to consist of hair, or of cocoanut fibre in a patient engaged in mat-making (c) Calculi have been found consisting of insoluble mineral salts, *e g*, carbonate of magnesia or chalk, taken as medicine Whatever their origin, such enteroliths are likely to become impacted near the cæcum, and may cause acute obstruction In thin persons their presence may be detected by palpation of the abdomen

3 *Foreign Bodies accidentally or intentionally swallowed* occasionally pass through the stomach and become lodged in the intestinal canal Lunatics and children are most frequently affected, and in the former the most astonishing collections are occasionally found Thus Professor Agnew reports that he saw, in the dissecting-room of the Philadelphia School of Anatomy, a female subject, afterwards learned to have been insane, in whose intestinal canal were found three reels of cotton partially unwound, two roller bandages, one of them  $2\frac{1}{2}$  inches wide and 1 inch thick the other was partially unrolled, one end being in the ileum, the other in the rectum, a number of skeins of thread, a quantity being packed tightly in the cæcum, and finally a pair of braces

The **Symptoms** caused by such conditions will be either those of intestinal obstruction (p 1107) or of perforation In the latter the process is usually gradual, rather than sudden, giving time for adhesions to form, thereby limiting the mischief Suppuration follows, and possibly the foreign body may be extruded by Nature or removed by the surgeon through the abscess cavity, with or without the formation of a fæcal fistula

Small spiculated foreign bodies, *e g*, fragments of glass or metal, the husks of cereals, etc., may sometimes lodge in the pouches of the colon, and give rise to localized inflammatory phenomena, perhaps in one or more of the appendices epiploicæ The symptoms will very closely resemble those of a localized appendix abscess, and similar operative treatment will be required

**Enteritis**, or inflammation of the mucous membrane of the intestine, is a condition usually treated by the physician, occasionally it complicates surgical cases and needs effective treatment Thus it may follow the exposure of a coil of intestine in the depths of a wound which has to be packed for drainage purposes Severe diarrhœa may result, and the inflammation may even spread through the whole thickness of the gut wall, and lead to the establishment of a fæcal fistula Enteritis also occurs as a post-operative complication of strangulated hernia (p 1098) Whatever its origin, it is always



characterized by diarrhoea of varying type, and by pain or abdominal discomfort and perhaps vomiting. *Treatment* consists in the use of a bland diet, *e g*, milk, and the administration of soothing astringent drugs, such as bismuth and perhaps opium. It must not, however, be checked without ascertaining so far as possible that the causative irritant has been removed, and not uncommonly the best treatment to start with is the administration of a good dose of castor oil.

**Colitis** is an affection occasionally needing surgical treatment. The cause is usually chronic constipation, but bacteria of various types or the *Amœba coli* may be present. In the simpler cases (*mucous colitis*) the patient complains of griping pains in the course of the colon, diarrhoea, the passage of mucus in the stools, perhaps in membranous flakes, and definite tenderness of the colon on palpation. The appendix is not unfrequently inflamed at the same time, and one of the most tender spots may be over this organ. *Treatment* of this form consists in emptying the bowel by enemata, keeping the patient quiet in bed on a milk diet, and possibly ordering bismuth or a little chlorodyne. When the patient is convalescent and all tenderness has disappeared, the causative chronic constipation must be treated. Purgatives usually cause irritation and pain, and must be as far as possible avoided. Abdominal massage and the methodical use of the so-called Swedish exercises, which increase the power of the abdominal muscles, and thereby give tone to the relaxed colon, will often work wonders in these cases.

The graver cases (*ulcerative colitis*) are associated with the discharge of pus and the exfoliation of patches of mucous membrane. The patient's health may be profoundly affected in this disease, pus of a most offensive type pouring out from the rectum, or fever of a marked hectic character being present. The nutrition is necessarily impaired, and the patient wastes to a shadow. Under such circumstances, and especially when rectal irrigation has failed, the surgeon may be asked to make an artificial opening into the cæcum in order to permit of more thorough irrigation, and also to deflect the intestinal contents. For the method of operating, see p 1020. The fluid employed for irrigation must be bland, non-toxic, and unirritating. Warm saline solution should be first used, and subsequently a weak boric acid solution, or possibly, with great care, a 1 in 5,000 solution of nitrate of silver. The patient sits over a bed-pan, and the fluid is injected through the fistula from an irrigator, distension of the bowel must be avoided, and to this end the introduction of a rectal speculum to keep the anus open during the irrigation is desirable. It has been suggested by Weir that the appendix itself might be used in this condition, fixing it in the wound and irrigating through it, by this means closure of the fistula after the disease is cured might be more easily effected. It is probable that some amount of stenosis of the bowel may result from the cicatrization of the ulcers in the colon, and then the fistula may have to remain permanently.

**Tuberculous Disease of the Intestine** usually occurs in the ileo-cæcal region, and manifests itself in two main types

1 **Tuberculous Ulcers** are generally multiple, though occasionally single. They are of the usual tuberculous type, with undermined margins, and extend in the course of the vessels and lymphatics, viz., around the gut transversely, so that if they heal stricture is almost certain to follow. In their early stages they do not require surgical assistance, but later on obstructive phenomena may supervene, and these may be due not only to the stenosis, but also to associated peritonitis, neighbouring mesenteric glands are usually infected, and together with the bowel and omentum may form a palpable mass. Operation may be needed for the relief of the obstructive phenomena, and some form of anastomosis, or even excision of the mass, may be undertaken if it be practicable.

2 The disease is sometimes chiefly limited to the cæcum, producing a well-marked tumour, which can be palpated from outside, and is sometimes known as the **Tuberculous Cæcal Tumour**, the disease may, however, also extend into the ileum and along the ascending colon for some distance. The intestinal wall is thick, congested, and infiltrated with a tuberculous deposit, the outer coat is rough and nodulated, and the mass is firm, but not hard to the touch. The neighbouring mesentery is occupied by enlarged glands, and these may also be found on the inner border of the ascending colon. Adhesions may be present, and lead to kinking or twisting of loops of bowel, which may assist in producing intestinal obstruction. The symptoms vary a good deal, but in the early stages constipation and diarrhoea may alternate, whilst later on obstructive phenomena may supervene, or even well-marked pyrexia of a hectic type. The diagnosis from a cæcal carcinoma is not always easy, the chief points in favour of tubercle are the earlier age (under forty years), the longer duration of symptoms (two or three years), the associated pyrexia, and the presence of tuberculous lesions elsewhere. The diagnosis is, however, not uncommonly made on the operating-table. *Treatment* consists in entero-anastomosis, or excision of the mass. The latter may involve an extensive procedure, but even when enlarged glands have to be left behind, the case may do well. Thus, one of us removed the cæcum, ascending colon, and a foot or more of the ileum for this condition, implanting the ileum into the side of the transverse colon, which latter viscus was not above suspicion. Many enlarged glands had to be left, but the patient made an uninterrupted recovery, and has remained well, the pyrexia, which was very marked, disappeared on the day of the operation, and never returned.

**Stenosis of the Intestine** arises from two main causes—the contraction of cicatrices or adhesions, and the development of tumours, usually malignant.

**Simple or cicatricial** stricture usually results (1) from the healing of ulcers which have extended more or less circularly around the bowel, or have involved its walls extensively. Hence, tuberculous ulcers lend themselves to its development more than the typhoid lesion, and it is a little doubtful whether it has ever occurred as a sequela of the latter. Syphilitic ulceration is followed by it, especi-

ally when involving the rectum, but the upper part of the jejunum is also occasionally affected. In the large intestine dysentery is the most common cause, and the stenosis, like the ulceration, may be irregular and extensive. (2) It may follow strangulated hernia as the result of ulceration along the actual site of constriction, and, similarly, it may develop after the separation of an intussusception. (3) An end-to-end anastomosis of the gut may lead to stenosis unless considerable care is taken not to tuck in too much of the gut wall. (4) The contraction of adhesions outside the intestine is by no means an uncommon cause, thus it may be due to many forms of localized peritonitis, and frequently ensues after pelvic cellulitis.

Owing to the contents of the *small* intestine being of a somewhat liquid nature, a stricture in this situation often exists for some time before symptoms of any urgency arise. The patient may complain of a certain amount of indigestion and discomfort, but sooner or later the narrowed aperture of the gut becomes blocked either by a fold of mucous membrane or by a portion of undigested food, and thus an attack of obstruction is induced. In the early stages of the disease this can be overcome and remedied by purgatives, but each recurrence is likely to increase in severity, until finally an acute attack supervenes, which kills the patient, unless relieved by prompt surgical interference.

In the *large* intestine very similar phenomena appear, but the attacks of obstruction are of a somewhat different character, since there is less pain and vomiting, and aperients, instead of relieving the patient, as they often do in the earlier attacks in the small gut, always aggravate the symptoms, there is also much greater distension of the abdomen. The diagnosis of stricture, though strongly suggested by the symptoms, can only be absolutely confirmed by an exploratory operation, except when the lower part of the rectum is involved.

The **Treatment** in the earlier stages consists of suitable dieting, and the administration of purgatives or of large enemata, and for a time such will be successful. Sooner or later, however, a more than usually serious attack of obstruction will call for something more radical, and we must refer readers to the chapter on obstruction for details of the treatment to be adopted. If on operating the stricture is found and recognised, enteroplasty or enterectomy should be undertaken, if the small gut is involved. For stricture of the cæcum or ascending colon, some short-circuiting method, whereby the ileum is implanted into the colon below the stricture (ileo-colostomy), is perhaps the best plan to adopt, in the transverse colon excision is possible, as also in the sigmoid flexure, whilst in the descending colon enteroplasty may be undertaken. Failing any of these radical measures, the establishment of an artificial anus in the bowel above the stenosis suffices to give relief. It must be remembered, however, that no permanent opening can be made more than a foot above the ileo-cæcal valve, since the absorption of nourishment is thereby so interfered with that death from asthenia is certain to follow in a very short time. The

intestinal contents, too, are fluid and very acid at this level, and give rise to much irritation of the skin

**Tumours of the Intestinal Wall** may be simple or malignant, primary or secondary. *Simple* tumours are unusual, and consist of papilloma, adenoma, myoma, lipoma, and a few other varieties. They may cause irritation and irregular action of the gut, resulting, perchance, in intussusception (p 1112), hæmorrhage, sometimes of a serious character, is associated with multiple papilloma or adenoma, and obstruction occasionally ensues. It is unusual for a diagnosis to be made apart from an exploratory laparotomy, unless the rectum is affected. The treatment is governed by the location of the growth and by the symptoms it causes.

*Sarcoma* of the intestine is not common, it may involve the ileum or cæcum, and gives rise to a localized tumour or diffuse infiltration. Obstruction may ensue, or considerable peritoneal irritation resulting in an abundant blood-stained exudation which leads to abdominal distension, and may be recognised as due to a new growth on tapping. Treatment consists in removal of the affected coil of gut if the disease has not progressed too far.

**Cancer of the Bowel** is almost always primary in nature, and is then usually a columnar carcinoma, to which colloid degeneration is sometimes added. The small intestine is rarely involved, but any part of the colon may be affected. Secondary growths are occasionally met with, and are necessarily of the same nature as the original tumour. The physical characters of the growth vary considerably, but usually conform to one of two types—viz, (1) the *hypertrophic*, in which a large mass forms, perhaps occupying the whole lumen of the bowel, but not necessarily. It is a fairly rapid growth, and usually associated with ulceration and hæmorrhage, whilst obstructive phenomena are late in appearing. (2) In the *sclerosing* form the tumour develops as an annular growth around the bowel, the lumen of which is contracted so that it may be almost impossible to pass a crow's quill or a probe through it (Fig 372). It is an astonishing feature of these cases that the function of the bowel is carried on

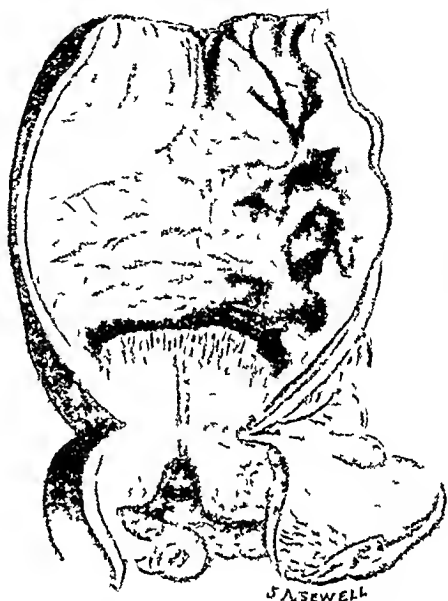


FIG 372 — CARCINOMA OF THE DESCENDING COLON

The growth was of the sclerosing type, and had given rise to no symptoms except a little diarrhœa until the onset of a fatal attack of obstruction.

without much pain or difficulty until the lumen is almost obliterated, and then suddenly a serious attack of obstruction occurs. Sometimes the bowel looks from outside as if a piece of string had been tied round it, so great is the constriction. Above the growth the bowel is hypertrophied and dilated, the mucous membrane is often congested, inflamed, and even ulcerated, the latter lesion is usually due to the irritation of stagnant fæces, and the ulcers are termed 'stercoral'. Bacteria may find their way into and through the intestinal wall from these foci, and lead to peri-intestinal suppuration, and as a sequela a fæcal fistula may develop. The bowel below the growth is usually distended ('ballooned') from paralysis of its walls, and the development of gases from the fæcal material which may accumulate from a loss of the *vis-a-tergo*, this can often be remarked in cancer of the rectum.

The irritation of the growth leads sooner or later to the formation of adhesions, which may aid in hampering the action of the bowel. Secondary deposits occur in the mesenteric glands and omentum, and less commonly in the liver or distant regions, but there can be no question that the growth is often much less malignant in type than cancer elsewhere.

The **Symptoms** are at first vague in the extreme, and the disease is likely to have progressed for some time before a diagnosis is reached. The patient complains of indigestion of an intestinal type, there may be some pain of a colicky character, and either constipation or diarrhoea may be present, not unfrequently they alternate, the constipation being primary, and the diarrhoea resulting from the decomposition of retained fæces, or a catarrhal enteritis set up thereby. A discharge of mucus or blood may be noticed in the stools, and the patient's nutrition begins to suffer, although wasting is at first slow.

The conditions which may require and justify interference by the surgeon are as follows: (1) Repeated attacks of slight obstruction, especially if localized resistance of the abdominal wall or an indefinite sense of fulness in some region is associated therewith, (2) an acute attack of obstruction, the nature and symptoms of which vary with the site of the lesion, (3) the existence of a tumour, which, though at first readily moveable, soon becomes fixed owing to the formation of adhesions to surrounding tissues, and (4) the development of a peri-intestinal abscess. On the other hand, if it is evident that secondary growths are present in the omentum or elsewhere, and the primary growth is so large or fixed that its removal is doubtful, it is useless to undertake merely an exploratory operation. In these cases it will suffice to interfere when obstructive phenomena make their appearance. The mere handling of such a growth, the inner surface of which is probably ulcerated, is often sufficient to determine increased activity of the bacteria, and the development of an abscess around the growth, which may be followed by diffuse or localized peritonitis, and even by the development of a fæcal fistula or artificial anus.

**Treatment**—Except under the circumstances just mentioned, whenever a diagnosis of malignant disease of the bowel has been made or is suspected, an exploratory laparotomy is justifiable in order to confirm or disprove the fact. Unfortunately, cases are usually left until the progress of the disease has settled the question, and then palliative treatment may alone be possible. If found early enough, the growth, together with a good margin of healthy tissue on either side, should be removed, and the intestinal canal restored by enterorrhaphy. Affected mesenteric glands are included in the part excised if possible, but the total removal of the growth is quite justifiable, even if glands have to be left, inasmuch as it restores the functional activity of the tube. It must be remembered, however, that unless the bowel has been well emptied previously it is often wiser to make a temporary artificial anus, and restore the continuity of the canal at a later date.

Should excision be impracticable owing to the extent or fixity of the growth, the following plans of treatment may be considered, and that which best suits the requirements of the particular case undertaken.

1 The growth may be *short circuited* by uniting portions of gut above and below it. This is usually accomplished by one of the forms of lateral anastomosis described hereafter, thus, the cæcum may be attached to the sigmoid flexure in a case of cancer of the transverse colon.

2 The bowel may be entirely divided above the tumour, and the upper end implanted into the gut below it, the lower end of the divided bowel being sutured (Fig 373). This *lateral implantation* is the best plan of treatment to employ for cancer of the cæcum which cannot be extirpated, the ileum is divided above the valve, and its open end implanted into the ascending or transverse colon well above the growth (ileo-colostomy), whilst the lower end is totally closed.

3 The affected coil of gut has been *excluded* from the intestinal tube by dividing the bowel above and below, and uniting the divided ends, whilst one end of the diseased coil is closed and the other is brought to the surface, and fixed there so as to establish a fistulous track. There is always a certain amount of discharge from the cancerous growth, and the mucous membrane itself secretes, so that total closure of the excluded loop would be accompanied by danger.

4 Finally, if none of these measures are applicable, or if the

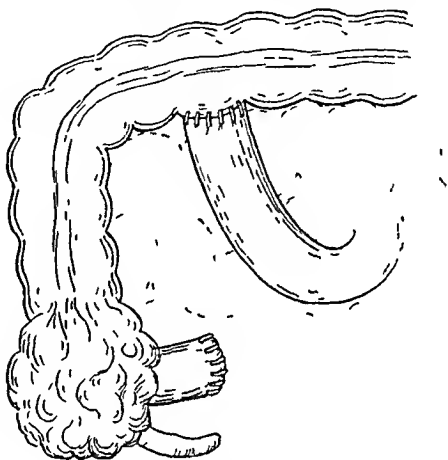


FIG 373—LATERAL IMPLANTATION OF DIVIDED END OF ILEUM INTO THE TRANSVERSE COLON FOR IRREMOVABLE CANCER OF THE CÆCUM (ILEO-COLOSTOMY)

patient's condition is such as to make it unwise to attempt them, and if the growth is situated in the colon, an artificial anus may be established

Idiopathic Dilatation of the Colon is a rare affection met with in infancy, but occasionally lasting on till young adult life. It is characterized by enormous distension of the colon, and usually of its lower portion, possibly on opening the abdomen nothing but the colon is seen. The walls are hypertrophied, and stercoral ulcers may be present. The cause in many cases is unknown, but congenital contraction of the rectum has been found in some. The most prominent symptom is constipation, and that usually of a most obstinate character, purgatives having no effect but to cause pain and vomiting. Enemata are often retained, and even gas cannot easily be passed, the introduction of a long flatus-tube is followed by the escape of very putrid gas in large quantities. Sooner or later urgent obstruction follows, and may cause death. **Treatment**—Purgatives must be avoided, but massage and electricity may do good. Colotomy may be needed for obstruction, and possibly the practice followed in one case by Sir F. Treves may be justifiable, viz, excision of the rectum, sigmoid flexure, and descending colon, the transverse colon being dragged down and fixed in the perineal opening.

**Enteroptosis**, or Glenard's disease, is a condition not uncommonly met with in which there is a general displacement downwards of the viscera. The small intestine, transverse colon, kidneys, and stomach are the organs chiefly involved, but any of the viscera may be affected. The cause varies and cannot always be ascertained, sometimes it commences after an acute illness, more usually it is chronic and develops gradually. The relaxed abdominal wall which follows repeated pregnancies is often present, and tight-lacing may be an important causative factor. Women are much more frequently affected than men. The condition *per se* is not necessarily associated with symptoms, but in a considerable number of cases marked neurasthenia is present. The amount of displacement is no measure of the severity of the symptoms. The stomach may be well below the costal arch, and when inflated stands out prominently, both curvatures being visible, it is usually distended atonically, and succussion sounds may be heard. The relaxation of the small intestines is alluded to in connection with the ætiology of hernia (p 1063). The transverse colon may sag downwards almost into the pelvis, and the kinking at the splenic and hepatic flexures thereby induced may be an important element in the production of constipation. The spleen and liver may also slip downwards. Displacement of the kidneys is referred to under the heading 'Moveable Kidney' (p 1152).

**Treatment** must be wisely modified according to circumstances, and due allowance made for the neurasthenic element. A course of Weir-Mitchell treatment (i.e., rest and feeding) is often valuable, both for its influence on the nervous state and also in assisting to increase the deposit of fat. Electricity and massage to the abdominal walls help to restore their tone and to improve the condition of the underlying

viscera An abdominal belt or bandage will do much to relieve symptoms, especially if applied with the patient in the Trendelenburg position Operation is not to be lightly undertaken, but if a fair test has been given to the above measures, it may be justifiable to open the abdomen and stitch up into place organs like the stomach, liver, or spleen For treatment of moveable kidney, see p 1153

### Operations on the Intestines

1 **Enterotomy** is a term which is only correctly applied to an incision made into the intestine either for the removal of a foreign body or for the examination of its interior The wound should always be placed in the longitudinal axis of the gut, and along its anti-mesenteric border, it is closed by a row of Lembert, Czerny-Lembert, or Halsted stitches

2 **Enterostomy**, or the formation of an artificial opening into the bowel, may be undertaken for several reasons, and any part of the gut may be opened (a) The jejunum may be brought to the surface and opened (*jejunostomy*) in cases of cancer of the stomach where gastro-enterostomy and pylorectomy are impossible and the patient is dying of inanition, he can subsequently be fed by the fistula in this way produced (b) The ileum may need to be opened and drained in cases of obstruction not lower than the cæcum or ascending colon, when the small gut is much distended and the patient's general condition so bad that no prolonged search for the cause and no attempt to deal directly with it, even if obvious, are possible The abdomen is opened either in the middle

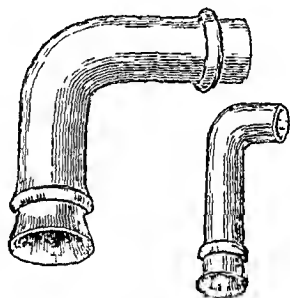


FIG 374 —PAUL'S TUBES  
(GLASS), LARGE AND  
SMALL SIZES

line or in the right iliac region, a suitable distended coil is withdrawn and opened after carefully protecting the peritoneal cavity from faecal infection A large trocar and cannula are first introduced, so as to allow the first gush of flatus and fluid contents of the gut to escape, the opening is then enlarged and a Paul's (glass) tube tied in (Fig 374), and the affected coil of bowel fixed to the abdominal wall A thin tube of rubber is attached to the other end of the glass tube, and through this the intestinal contents are temporarily allowed to escape without contamination of the peritoneal cavity or of the wound

If the patient recovers from the acute symptoms, a second operation will be needed in order to re establish the continuity of the intestinal canal Life is not likely to be of long duration if an artificial opening exists above the cæcum, as the exclusion of the absorbing mucous surface of the large intestine seriously hampers nutrition

(c) **Colostomy**, or, as it is more usually termed, 'colotomy,' is frequently employed in dealing with diseases of the lower bowel, and is an extremely successful proceeding



The character of the artificial opening varies considerably according to whether or not it is intended to be a permanent condition. If merely a temporary opening is required, the smaller the portion of bowel secured to the parietes the better, since the subsequent operation for its closure is so much simpler (Fig 375). But where a permanent aperture has to be established, the surgeon's aim should be to deflect totally the course of the *fæces*, and hence it is desirable to withdraw a portion of the gut from the abdominal cavity, and to cut away a complete segment, including also, if possible, a portion of the mesentery. By this means the upper and lower openings are brought to the surface of the skin, and separated from one another by an area of cicatricial tissue representing the section of the mesentery (Fig 376).

The ascending colon, or preferably the *cæcum*, is occasionally opened in cases of membranous or ulcerative colitis where there is an abundant secretion of pus, and the patient's life is threatened by pyrexia and toxic exhaustion. The object of the operation is twofold, viz, to prevent the irritation caused by the passage of the *fæces* over the ulcerated mucous membrane, and to permit the colon to be irrigated. Inasmuch as the contents of the bowel at this level are fluid and very acid, it is wise to make the opening as small as possible, and this may be done by stitching firmly into the bowel a piece of rubber drainage-tube in the same manner as for gastrostomy (p 999) and then fixing the bowel to the skin and abdominal muscles. It is possible, however, that in spite of every precaution the skin will become irritated. If the opening has to remain for some time, the patient must be provided with an abdominal belt to which is fitted an elastic pad carrying a solid rubber plug which fits into the opening.

Intestinal obstruction of the hepatic flexure sometimes necessitates a cæcal colostomy, which is performed as for the small intestines, a Paul's tube being tied in. A secondary operation is usually required in order to excise the cause of the obstruction, or to short-circuit it.

The transverse colon is most likely to require opening for obstruction located in the splenic flexure, as by carcinoma or adhesions. In all probability the source of the trouble has not been recognised prior to operation, the abdomen is opened for exploratory purposes in the middle line, and in order to relieve the urgent symptoms the distended transverse colon has to be opened at once. Necessarily the situation is not a desirable one for an artificial anus, and therefore should be only of a temporary character, in order to give relief to the urgent symptoms. When this has been effected the abdomen should be again opened, and some form of anastomosis performed to short-circuit the obstruction. A small portion of the bowel wall is therefore stitched to the surface, and the colon opened in a day or two when adhesions have formed, or, if the case is urgent, the bowel is incised at once, a Paul's tube tied in, and the gut then fixed to the abdominal wall with as little protrusion as is considered safe.

The descending colon or sigmoid flexure is the portion most frequently opened. Two chief methods have been employed—viz, the

*lumbar* operation, in which the upper part of the descending colon is reached behind or through the peritoneum, and the *iliac*, in which the upper part of the sigmoid flexure or lower end of the descending colon is brought to the surface after opening the peritoneal cavity

*Uses of Left Lumbar or Iliac Colostomy*—The operation is required under the following conditions (1) For congenital absence of the rectum, when a perineal incision has failed to discover it, (2) for chronic obstruction of the lower end of the large intestine, which cannot be relieved by enemata or medical means, such as that arising from simple or malignant stricture, or from the pressure of pelvic tumours, (3) for carcinoma of the rectum or sigmoid flexure, whether obstruction is present or not, if a radical operation is impracticable, or as a preliminary to excision, (4) for some cases of syphilitic and

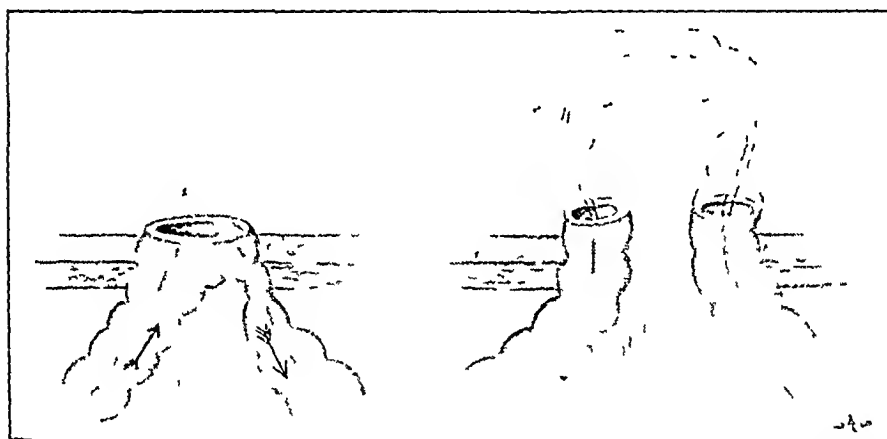


FIG 375 —DIAGRAM OF TEMPORARY COLOSTOMY SHOWING THE SINGLE OPENING ON A LEVEL WITH THE SKIN, THE PASSAGE TO THE LOWER BOWEL BEING MERELY BLOCKED BY A SPUR OF MUCOUS MEMBRANE

FIG 376 —DIAGRAM OF PERMANENT COLOSTOMY, SHOWING THE TWO OPENINGS SEPARATED ONE FROM THE OTHER BY A SECTION OF THE MESENTERY

The dotted portion indicates the amount of bowel cut away but, of course, such an extensive resection is only practicable when there is a very long mesentery, which is unusual

other forms of ulceration of the rectum, which cannot heal as long as they are irritated by the passage of fæces, (5) for irremediable cases of recto-vesical and recto-vaginal fistula, whatever their origin, (6) for volvulus of the sigmoid flexure, the *iliac* operation being needed not only to relieve the obstruction, but also to prevent recurrence

*Left Lumbar Colostomy (Amussat's Operation)* has been much neglected of recent years, and practically replaced by its *iliac* rival. Performed as it was in the old days without opening the peritoneal cavity, this operation was certainly not a desirable one, but if the method described below is adopted, it will probably be found as

efficient as the iliac proceeding. The patient lies on the right side, with a sandbag beneath the loin, so as to increase the space between the last rib and the crest of the ilium. The position of the colon is indicated by a vertical line drawn upwards from a point  $\frac{1}{2}$  inch behind the centre of another line, passing from the anterior to the posterior superior iliac spine.

The centre of the incision should correspond to this line midway between the last rib and the crest of the ilium. It should be made parallel to the last rib, and for practical purposes may commence at the outer border of the erector spinæ, and pass outwards for about 4 or 5 inches (Fig 422, A, p 1151). This incision is carried through the layers of the abdominal muscles, dividing the latissimus dorsi and a small portion of the external oblique, and beneath this the posterior attachments of the internal oblique and transversalis muscles, constituting the fascia lumborum. This should be cleanly divided along the whole length of the incision, the last dorsal nerve and first lumbar artery being usually included. The sheath of the quadratus lumborum is opened, and the outer fibres of the muscle notched, if necessary. The deeper portions of the wound are now held apart by spatulæ, and the loose fatty subperitoneal tissue gently torn through with the fingers and forceps, it varies considerably in amount and consistency.

If the gut is distended, it may at once come into view, but if collapsed, it is not recognised at once. In about 20 to 30 per cent of individuals a true peritoneal descending meso-colon is present. Under any circumstances the peritoneum is opened in the anterior portion of the wound, and the colon definitely looked for and identified. The highest portion that can be reached is secured, so that there shall be no slack intestine above the opening to give rise later on to prolapse, for choice, one fixes the end of the transverse colon to the skin.

If the case is not urgent, the loop of bowel is withdrawn from the wound, and secured to the skin by sutures which merely involve the sero-muscular coats, the rest of the parietal incision is closed. After a few days the bowel is opened. It is well to fix it as far back in the wound as possible, so as not to leave a pocket behind in which discharges might accumulate. If, however, urgent obstruction is present, requiring immediate relief, the bowel is drawn out of the wound and opened with the same precautions as in the iliac procedure. A trocar and cannula is introduced to give exit to the first gush of flatus and fluid fecal matter, and then a Paul's tube is tied in, the bowel stitched to the skin, and the rest of the wound closed.

Lumbar colostomy is not much in favour at the present day, but there are eminent and up-to-date surgeons who maintain that in reality a lumbar opening is more comfortable and convenient than one in the iliac fossa, and that it is much easier to control the escape of feces than in the latter proceeding.

**Iliac Colostomy, or Littré's Operation,** consists in opening the lower

portion of the colon or sigmoid flexure through the anterior abdominal wall. An incision 2 to 3 inches in length is made at right angles to a line extending from the anterior superior spine to the umbilicus, the centre of the incision corresponding to the junction of the outer and middle thirds (Fig 363, D). The abdominal parietes are divided, and the peritoneum opened. Two fingers are then inserted, and the sigmoid flexure sought for, it is recognised by the presence of the appendices epiploicæ and the longitudinal bands of muscle fibres. It is carefully examined, and the upper part of it selected for fixation in the wound, so as to diminish the risk of subsequent prolapse. It is desirable to withdraw a coil about 4 or 6 inches in length, together with its mesentery. Many different plans of fixing it are in vogue, but the method we prefer is to pass a strong silk thread through the parietes and parietal peritoneum on either side of the wound, the stitch traversing the mesentery *en route*. It is then made to traverse

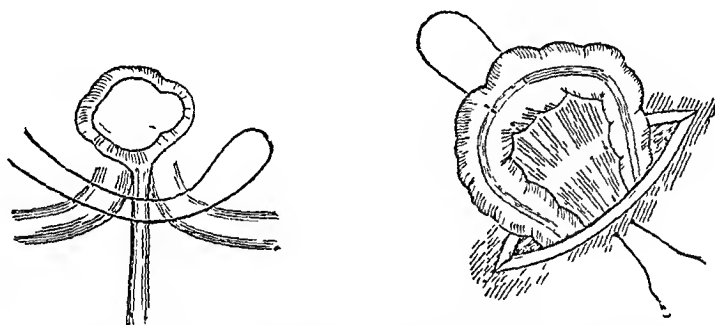


FIG 377—ILIAC COLOSTOMY TO SHOW FIXATION STITCH PASSING THROUGH MESENTERY AND ABDOMINAL PARIETES

the same structures once more in exactly the same way, but at a distance of about  $\frac{1}{2}$  inch from the former (Fig 377). The loose ends are then tied together, so as to bring the parietal peritoneum and sigmoid meso-colon into close apposition. A few additional stitches should be inserted, uniting the skin to the longitudinal muscular bands at each end of the incision, so as to prevent any subsequent retraction of the exposed bowel or escape of small intestine. Some surgeons simply secure the parietal peritoneum to the gut by a row of carefully inserted sutures, others pass a glass rod through the mesentery and stitch the peritoneum to the skin, whilst it has also been suggested to make a hole through the mesentery and suture the two edges of the incision through it, *i.e.*, beneath the bowel. The projecting portion of gut is then covered with purified protective, and an antiseptic dressing applied. At the end of two or three days the bowel is opened, no anæsthetic being generally necessary for this proceeding. About the eighth day a portion of the whole lumen of the gut should be removed, down to and even including the mesentery, so as to completely separate the upper from the lower end, and thus establish an efficient spur. The deep stitch is removed about the twelfth day. Should it be necessary to

open the bowel at the time of operation, the distended coil is first withdrawn and the deep trans-mesenteric stitch passed and tied. The margins of the wound are then carefully protected by antiseptic compresses, and the bowel is tapped with a trocar and cannula. When the first gush of flatus and fæces has escaped, the opening is enlarged and a large sized Paul's tube tied in. The skin is then carefully sutured all round to the bowel and mesentery, and a collar-like pad of gauze protects the junction. The tube is probably set free about the fourth day by sloughing of the portion of bowel grasped by the ligature, but the wound is by that time well protected, and no risk of intra-peritoneal infection exists. If a Paul's tube is not to hand, a large drainage-tube without lateral openings can be stitched into the bowel in its stead.

When cicatrization of the wound is complete, a protective apparatus is required in order to keep the patient clean. This should consist of a hollow oval cup, made of plated metal, vulcanite, or celluloid, with a rolled edge, and kept in position either by a truss spring or an abdominal belt. This hollow cup should be large enough to include a 2-inch margin of skin all round the opening, and in the concavity a small portion of antiseptic dressing is placed. Such an apparatus enables the patient to go about in comparative comfort, the bowels are encouraged to act thoroughly every morning by means of an enema, so that no further disturbance need occur during the day.

**Comparison of the Two Operations** — When the lumbar operation did not include opening the peritoneal cavity, its difficulties and dangers were not inconsiderable, and one can fully understand the reasons why it was discarded so completely. The colon was often difficult to find, and a good deal of bruising and tearing of the subperitoneal fat resulted, occasionally some other coil of intestine was opened by mistake, whilst it was difficult or impossible to draw the gut to the surface so as to make an efficient spur. The wound became infected, and serious cellulitis was likely to follow.

At the present time the methodical and deliberate opening of the peritoneal cavity obviates nearly all of these difficulties, and the *advantages of the iliac operation* are not nearly so pronounced as formerly. (a) One great advantage is the greater proximity to a pelvic growth, which can be carefully examined, as also the lymphatic glands in the meso-rectum or lumbar region, and valuable indications as to the advisability or not of excision of the rectum can be thereby obtained. (b) An artificial anus situated in the iliac region can be attended to by the patient himself without assistance, and is more easily cleansed and protected. (c) It is occasionally possible for a certain amount of sphincteric control to be developed after the abdominal operation, owing to the muscles of the abdominal parietes becoming adherent to the coats of the gut. Of course, this can only be attained when these structures are brought into accurate apposition, as by the fixation stitch described above, or, better still,

by uniting the margins of the abdominal wound through a hole in the meso-colon. The conditions are only favourable for this in a few instances.

It is sometimes desirable to close a colostomy wound after a shorter or longer interval. The plan usually adopted at the present day is to dissect up the margins of the wound, freeing the gut from its attachments to surrounding parts, and excising the affected segment, in this way the continuity of the canal can be restored without leaving parietal adhesions. Occasionally it may seem desirable to close the opening without encroaching on the peritoneal cavity. It is then necessary to efface or remove the spur, which would otherwise hinder the onward passage of the fæces. This may be effected by stitching a piece of drainage-tubing of large calibre into the bowel so as to reach above and below the opening, the margins can then be pared and closed in some suitable way, after a time the stitches in the drainage-tube (catgut by choice) will be absorbed, and it will pass on down the canal. In still other cases where the spur is more prominent, it may be necessary to destroy it by a suitable clamp (*e.g.*, Dupuytren's enterotome) before attempting to close the opening. It must not be overlooked, however, that this latter method of dealing with an artificial anus is extremely unsatisfactory, as it leaves an adherent coil of intestine, which is certain to hamper peristalsis and may cause recurrent colic, or may even determine an attack of obstruction, the open operation is usually very successful.

3 **Enteroplasty** is a plan of treatment which has been devised for dealing with cicatricial strictures of the intestine, and is based on the same idea as the operation of pyloroplasty for fibrous stenosis of the pylorus (p. 1001). A longitudinal incision is made through the stenosed gut along the anti-mesenteric border, this is opened out, and converted into a transverse cleft, which is carefully sutured, the lumen of the bowel being thereby considerably increased.

4 **Enterectomy**, or excision of a portion of the bowel, is required in the following conditions: (*a*) For the removal of gangrenous gut after strangulation, whether internal or external, (*b*) in the treatment of multiple penetrating wounds, as after a stab or gunshot injury, (*c*) in dealing with an artificial anus or fæcal fistula, (*d*) for the removal of simple or malignant strictures, and (*e*) in some cases of intussusception. Not long ago the operation was but rarely undertaken, and the results were most unsatisfactory, but at the present time a very considerable degree of success may be expected, and enterectomy is frequently practised. Naturally, the results vary largely with the condition for which it is performed, with the site of the lesion, and with the experience and skill of the operator, a much higher rate of mortality follows when the excision is done for malignant disease, for gangrene following strangulation, or for intussusception, than when performed for other causes. Operations on the large intestine are also much less favourable than those directed to the small gut.

Whenever practicable, the bowel should be thoroughly emptied

prior to operation, and rendered as sterile as possible by the use of such drugs as calomel (gr 1 daily), salol,  $\beta$  naphthol, naphthalene, bismuth subnitrate, etc, for a few days previously. The abdomen is opened by any suitable incision, and the portion to be removed clearly defined, the general peritoneal cavity being protected by a careful packing with sponges or gauze.

The bowel must then be *clamped* on either side of the seat of operation, so as to prevent the escape of intestinal secretions or feces. Any of the forms of clamps figured in surgical instrument catalogues will effect this purpose, and amongst the best are those devised by Makins or Lane, but if they are not obtainable, the same result can be obtained by passing a piece of drainage-tube through the mesenteric attachment, and tying or clamping it around the gut.

The affected portion is now removed by scissors, cutting through the bowel and taking away a V-shaped portion of the mesentery, after securing as far back as possible the main nutrient vessels to the diseased area, according to Murphy's recommendation. It must be remembered that the terminal vessels run circularly round the gut, and have but little lateral anastomosis, and therefore it is desirable that the incisions should slightly diverge from the mesenteric attachment, otherwise the projecting edge of the anti mesenteric border is certain to slough, and septic peritonitis will result. Some operators recommend that the mesentery should not be cut into, but that the gut should be detached from the mesenteric junction, such practice will suffice when merely a small segment of bowel is to be removed, but if a large portion needs resection, it would take a much longer time to secure all the bleeding-spots. The wound in the mesentery is subsequently secured by sutures, and the divided ends of the bowel united by one of the many forms of anastomosis described below.

5 **Entero-anastomosis** is required for any condition in which there is a solution of continuity of the intestinal wall, and necessarily the methods employed vary according to the character and situation of the lesion. We have already alluded to the plans that are utilized in dealing with longitudinal wounds of the gut. The two chief methods that remain to be discussed are the end to end union of a totally divided segment of the bowel, and the means whereby lateral approximation or union is secured.

For **end to-end union** the following are the chief plans that have been adopted.

A **Entero-anastomosis by simple suturing**. In this the surgeon utilizes no special apparatus, but trusts to the deftness of his fingers and the accuracy of his stitches.

The mesenteric and anti-mesenteric borders are first united by stitches which are left long for the assistant to hold, the gut is thereby steadied (Fig 378). The mucous membrane is then sutured up by catgut stitches, which should not be continuous all round the junction, as thereby it might be drawn in too closely and contracted, it is best taken up in two or three portions. The sero-muscular

coats are now united all round by one or two continuous stitches of the Lembert or Cushing type. Extreme care must be taken in dealing with the mesenteric attachment, as the peritoneal coats separate there in order to enclose the bowel, and the muscular coat retracts considerably, leakage is more likely to occur at this point than at any other.

Some surgeons advise that the first row of stitches should include the whole thickness of the gut, and that the second row should be of the Lembert type. With this we do not agree, as it involves too great an infolding of the gut wall, and thereby the lumen at the site of anastomosis is unduly encroached on, and some amount of stenosis may result.

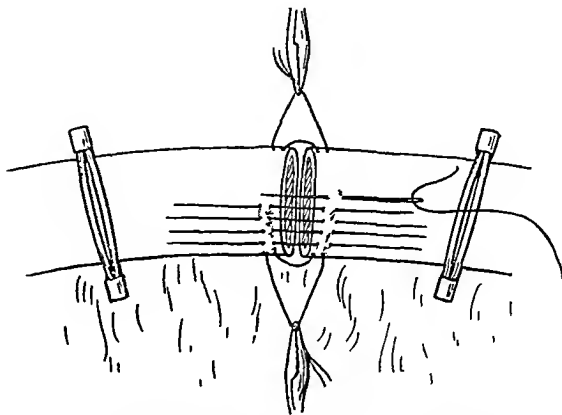


FIG 378—METHOD OF UNITING DIVIDED ENDS OF THE SMALL INTESTINE BY INTERRUPTED LEMBERT SUTURES

For clearness' sake the first row of stitches in the mucous membrane has been omitted

In the *large intestine* this type of anastomosis is not always easy to accomplish, owing to the greater complexity of the peritoneal relations. It is often necessary to introduce the sero-muscular stitches first on the posterior aspects of the section, and subsequently those for the mucous membrane, but it is an open question whether a lateral anastomosis is not a better procedure in dealing with the colon. One thing is quite certain—viz., that unless the colon is satisfactorily empty, no anastomosis should be attempted until the bowel has been effectively drained, and hence a temporary colostomy is often necessary, and resection or anastomosis is performed as a secondary procedure.

B A vast amount of ingenuity has been expended in the production of a variety of *bobbins* and *buttons*, with the idea of facilitating entero-anastomosis and making it safer. The methods of attaining this object vary, but according to the underlying principle one may divide them into two groups.

(1) Those which aim merely at providing an internal splint, which shall serve as a firm support to facilitate the introduction and tying of the stitches, and shall subsequently protect the line of union for a time. A hollow tube of turnip or potato will do quite well, but *Robson's bobbin* (Fig 379), made of decalcified bone, is perhaps more convenient in that it can be kept ready for use in a variety of sizes. Mr Robson recommends that two continuous sutures should be employed, one to unite the divided ends of the mucous membrane, and the other to approximate the serous and muscular coats.



(Fig 380) It will be found advantageous to have a curved needle at each end of these. The sero-serous suture is first introduced for the posterior half of the incision, each stitch taking a firm grip of the sero-muscular coats up to about a centimetre from the margin. The muco-mucous suture is then put in for the same extent. The bobbin is now placed in position, the muco-mucous suture is first finished and tied, and finally the anterior half of the sero-serous suture is similarly completed. Each of these sutures must be *firmly* tied around the bobbin so that no slipping is possible. The material of which it is composed (decalcified bone) is such as to do no subsequent harm to the mucous membrane, since it becomes soft and pulpy in the course of a few days.

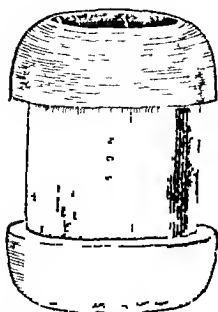


FIG 379 — MAYO  
ROBSON'S BOBBIN  
(DOWN BROTHERS)

(2) The majority of buttons aim at the approximation and apposition of the divided segments. *Murphy's button* (Fig 381) may be looked on as the type of all these contrivances. It is made of steel, and consists of two halves,

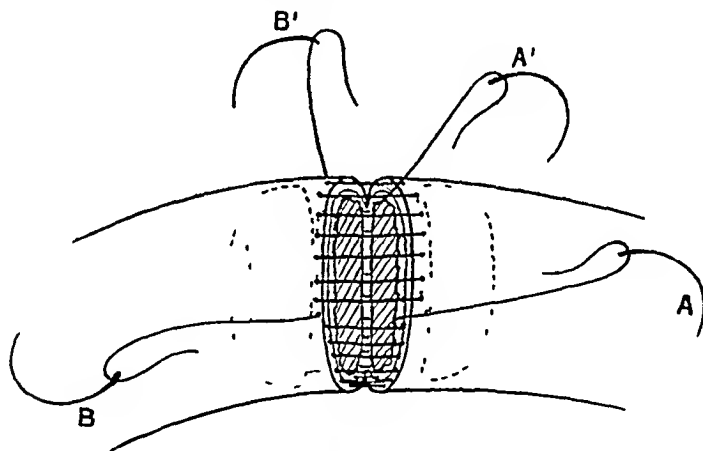


FIG 380 — ENTERO-ANASTOMOSIS OVER A ROBSON'S BOBBIN

A, A' is the internal suture for approximating the edges of the mucous membrane. B, B' is the external continuous sero-muscular stitch introduced according to Cushing's method.

which can be easily approximated, but are separated only by unscrewing. In the male half there is an additional inner cup or flange (P), separated from the former by a spring (c), so that when the two halves are approximated, the inner cup is kept constantly pressed against the female half (Fig 384), and thus pressure-atrophy of the tissues grasped between the two segments results, ultimately setting the button free. In the meantime, however, a sufficient formation of lymph will have occurred along the line of junction of the two to prevent extravasation and to secure union.

In performing end to-end anastomosis, a running thread is inserted through each end of the divided intestine in the manner shown in Fig 382. A half-button is introduced into each end of the divided gut, and preferably the heavier male end into the lower segment, the stitch is then drawn tight and tied, so as to gather up the gut wall round the central stem of the button (Fig 383). The two halves are now approximated (Fig 384), sufficient force being employed to bring the walls of the gut into accurate apposition, but without exercising injurious pressure.

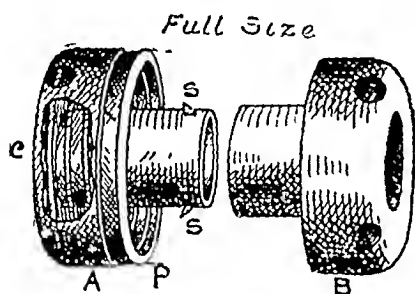


FIG 381 —MURPHY'S BUTTON

A, Male half B, female half P, inner cup or flange of male half, governed by c, spring, S, spring catches working along a screw thread on the inner aspect of the central stem of the female half

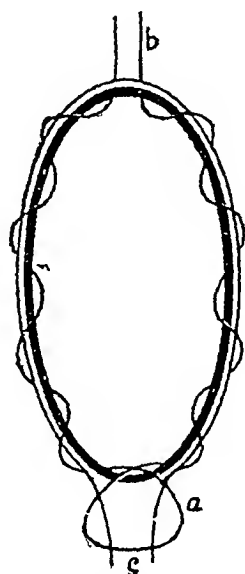


FIG 382 —METHOD OF INSERTING SUTURE FOR END TO END ANASTOMOSIS WITH MURPHY'S BUTTON

a, Overstitch to secure mesenteric attachment, b anti mesenteric border and two ends of suture, c, mesenteric attachment

The button is generally set free about the seventh day, and should pass downwards, and be expelled any time from the fourteenth to the twenty-first day.

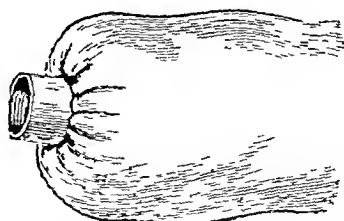
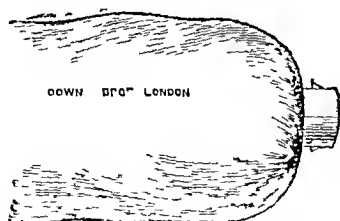


FIG 383 —APPEARANCE OF INTESTINAL SEGMENTS WITH MURPHY'S BUTTON TIED IN (DOWN BROTHERS)

Whilst fully acknowledging the enormous educational value of this contrivance, in that Murphy thereby demonstrated to the profession the principles that underlay the operation of entero-anastomosis and showed that success ought to be possible in a large percentage of

the cases, yet the button itself has done its work, and is now but little used. The only advantage is the rapidity with which the anastomosis can be performed. Obviously, the introduction of a large metal instrument of this type into the intestinal tube cannot be devoid of great dangers, and fatal issues have certainly occurred from sloughing, from want of union due to the use of too large a button, or of one badly constructed, and even from subsequent obstruction and perforation when it has passed lower down. On the whole, one would be inclined to use it for end-to-end anastomosis only when time is of value, and the patient's general condition such as necessi-

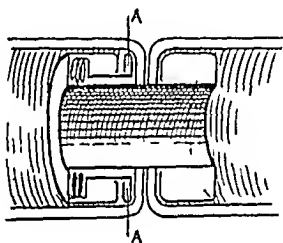


FIG 384—LONGITUDINAL SECTION OF INTESTINE WITH MURPHY'S BUTTON IN POSITION

A, A indicates the inner cup united to the outer by springs which determine pressure atrophy of the portion of gut wall grasped by the button

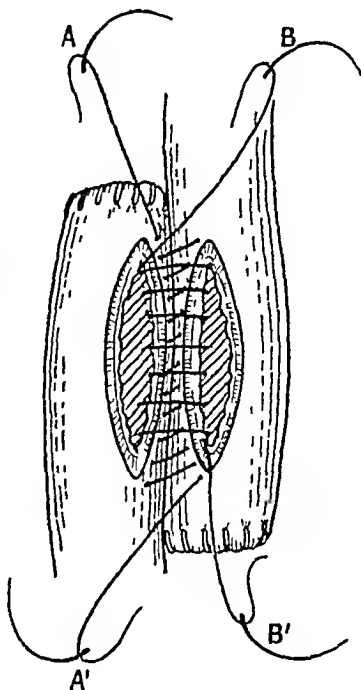


FIG 385—LATERAL ANASTOMOSIS OF BOWEL AFTER COMPLETE DIVISION

The divided ends are closed by sutures and approximated by a sero-muscular continuous stitch (A, A'), the incisions in the bowel are then made, and the mucous membranes united by a continuous stitch (B, B') and, finally, the sero-muscular suture is carried round the whole opening

tates the utmost speed in operating, under other circumstances one would always employ some other method

Many imitations of Murphy's button, made of decalcified bone, etc., have been introduced, but they are of no special value

6 **Lateral Anastomosis** of the intestine is usually undertaken in order to effect the short-circuiting of some malignant growth, or of a stricture which cannot otherwise be dealt with. It is sometimes employed instead of end to-end anastomosis to unite divided segments of intestine. The open ends are first entirely closed by Lembert or Czerny-Lembert stitches, and the portions of bowel made to overlap

The actual anastomosis is performed as for gastro-enterostomy (Fig 385) The sero-muscular coats on the posterior aspect of the proposed junction are first united, then the incisions are made, a continuous stitch unites the mucous membrane all round, and finally the external sero-muscular stitch secures the anastomosis. If thought desirable, a Robson's bobbin may be introduced.

7 **Lateral Implantation** is a procedure not uncommonly required in order to short-circuit a malignant growth (Fig 373). It is perhaps employed most frequently for irremovable cancer of the cæcum, the ileum is divided well above the growth, the lower end is closed, and the upper united to the transverse colon. The junction may be made by simple suturing, two rows of stitches being introduced, or a Murphy button may be used, and in this procedure excellent results follow its employment. The female half is tied into the divided end of the ileum by a stitch as for end-to-end anastomosis. The male half is secured into a longitudinal incision in the colon by a simple purse string suture, passing through the entire thickness of the gut wall. This operation of ileo-colostomy is the only one for which we consider Murphy's button generally applicable.

### Appendicitis (*Syn* Perityphlitis, Epityphlitis, etc.)

Appendicitis is an affection which may appear at any time of life, but is most common in young adults. The male sex is more frequently attacked than the female, in the proportion of 3 to 1. The disease is sometimes of but slight significance, but occasionally runs such a virulent course as to destroy life in a few hours. Its importance lies in the fact that it is an infective process, and inasmuch as the peritoneal envelope is generally involved, a certain degree of peritonitis is almost necessarily a consequence.

**Ætiology**—Many different conditions contribute either directly or indirectly in determining an attack of appendicitis. (1) The appendix is to be looked on, not as an actively functional structure, but as a degenerated relic or remnant, which is apparently of little value or importance. Hence, as in other similar structures, it often has but a poor blood-supply, derived from the posterior ileo cæcal branch of the ileo colic artery. The main nutrient vessels traverse the meso-appendix, but a second twig often runs down the base of the mesentery, and is more or less independent of the others. In the female it is said to have an additional supply from the right ovarian artery, and this may explain why the disease is less common in females than in males. Some authorities join issue with the above-mentioned view as to the utility of the appendix, and maintain that it secretes a fluid which stimulates the peristalsis of the cæcum or colon. This may be so, but the fact remains that a vast number of people who have lost their appendix by operation get on quite as well without it. (2) A large amount of lymphoid tissue is present in the mucous membrane, so much, in fact, that the title of 'abdominal tonsil' has been applied to it. Inflammatory processes are thus readily set up within

its walls as a result of the absorption of toxins or organisms, which are almost constantly present within it. (3) Its length and direction vary considerably in different individuals. In length it may measure anything between  $1\frac{1}{2}$  and 11 or 12 inches, but is usually 3 to 4 inches long, whilst as to direction, it may lie in any axis, perhaps most frequently it is to be found behind the cæcum, and pointing down towards the pelvis. The facility with which the intestinal contents find their way into its lumen thus varies in different individuals, and it seems probable that appendicitis is more commonly met with where it is so placed as to readily admit material which is with difficulty expelled, i.e., when it is transverse or directed downwards. A long appendix is also more liable to become twisted on itself. (4) The extent to which the meso-appendix is attached is also an important element, since the portion which projects beyond its free border is less well supplied with blood. As a matter of fact, the mesentery often does not extend beyond the junction of the middle with the distal third, and perforation not unfrequently occurs about this spot. (5) The communication with the cæcum is usually a small one, and is guarded by an insignificant fold of mucous membrane, known as the valve of Gerlach. Sometimes this aperture becomes blocked, or the orifice stenosed, as the result of a preceding attack of typhlitis or inflammation of the mucous lining of the cæcum, so that an accumulation of mucus occurs within the appendix. (6) The contents of the appendix consist of a little mucus and a large number of bacteria, similar to those found in the neighbouring intestine, they do no harm unless the mucous lining is so damaged as to permit them to invade the living tissues, and then they become virulent. *Foreign bodies*, such as pips, pins, etc., are occasionally found within it, and by their presence and irritation may light up an attack of inflammation. They are much less common than was formerly imagined (less than 4 per cent of the cases), and the fact that the opening into the intestine is generally not larger than to admit a No 8 catheter will explain this rarity. *Fæcal Concretions* are much more common, being present in 15 to 20 per cent of the cases. They are oval bodies, rarely more than  $\frac{1}{2}$  inch in length, on section they are found to be laminated, and consist of dried fæcal material mixed with myriads of bacteria, and perhaps with a pip or foreign body as a nucleus. They are not very hard, and can easily be cut with a knife, or even crushed between the fingers. They are usually the result of a preceding attack which has left the tube contracted, and thus determined stasis and retention of its contents, which have undergone decomposition. (7) Appendicitis is not unfrequently associated with a true typhlitis, probably due to chronic constipation, the continuity of the mucous lining of the cæcum and appendix explains this fact, which must always be taken into consideration in estimating the benefits which may be expected from removal of the appendix. Much disappointment in the non-relief of symptoms has arisen from the persistence of a typhlitis after the appendix has been removed. Dysenteric ulceration may involve the appendix, or lead

to stenosis of its orifice, but it is rarely implicated in typhoid fever. Tubercle and actinomycosis may affect it concurrently with the cæcum. (8) *Injury in the shape of a strain or sudden twist* is not unfrequently mentioned as the cause of an outbreak, and probably acts by displacing a long appendix in such a way as to lead to its kinking and possibly to obstruction of the nutrient vessels. When a concretion is present it is easy to understand that the final attack is determined by some traumatism which will modify the vascular conditions around it. When an appendix is filled with muco-pus as a result of stenosis, either at the orifice or in the tube itself, a blow may lead to its rupture and cause an outbreak of acute diffuse fatal peritonitis.

There can be no question as to the greatly increased frequency of appendicitis at the present day, especially amongst those who live in large towns or cities. It is difficult to assign any one cause for this, but possibly many conditions may be at work, *e g.*, (a) dental degeneration and consequent oral sepsis, (b) the bolting and non-mastication of meals associated with the hurry and scurry of modern life, leading to chronic irritation of stomach and bowel. (c) Chronic constipation is a most important factor. (d) The presence of minute foreign bodies in imported corn and other food-supplies may have some influence, whilst the chips derived from enamelled cooking utensils are by some considered of importance.

**Pathological Anatomy**—Whatever the assigned cause may be, it must ever be kept in mind that appendicitis is an infective malady, due to invasion of the walls of the appendix by organisms, especially the *Streptococcus pyogenes*, the *B coli*, and other anaerobic intestinal bacteria. These find an entrance into the wall of the appendix either through an eroded area of the mucous membrane due to the impaction of a foreign body or of a faecal concretion, or else they are absorbed into the lymphoid tissue so abundantly present, and at once commence to develop and multiply. The results may be best described under the following headings.

(1) **Changes in the Appendix Itself**—These vary considerably in intensity and character according to the cause and the power of resistance of the individual.

In the *simple or catarrhal* type the appendix looks red and swollen, and its peritoneal surface may be smooth, or roughened by loss of endothelium and deposit of lymph. It feels stiff from effusion, and has lost its natural flexibility. The muscular coats are often infiltrated with leucocytes, and this is especially noticed around the hiatus muscularis through which the vessels enter. The mucous membrane is thickened, engorged, and infiltrated with polynuclear leucocytes. The epithelium may be thickened, and here and there erosion or ulceration is present. If the process goes no further, healing occurs after a time, and this is often associated with fibrosis, which may show itself (a) as a more or less generalized sclerosis of the whole appendix, which may remain stiff and hard, and is perhaps twisted on itself (Fig 386), or (b) as a stricture of the tube, which

leads to retention of secretion, possibly to the formation of a faecal concretion distal to the stricture, and frequently to a recurrence, which is often of a severer type than the original attack, or (c) obliteration of the appendix may occur from the union across its lumen of granulating surfaces. This usually commences at the tip

and works up towards the gut, but is not completed until the patient has suffered from many attacks.

In the *ulcerative* variety, the loss of substance of the mucous membrane may be slight or extensive, it may be a simple erosion associated with a mild catarrhal attack, or a deeper loss of substance due to the presence and impaction of a faecal concretion, or it may result from a specific infection, as from typhoid fever or tuberculous disease. The appendix is likely to be more seriously invaded with micro-organisms, and may manifest any form of suppurative invasion.

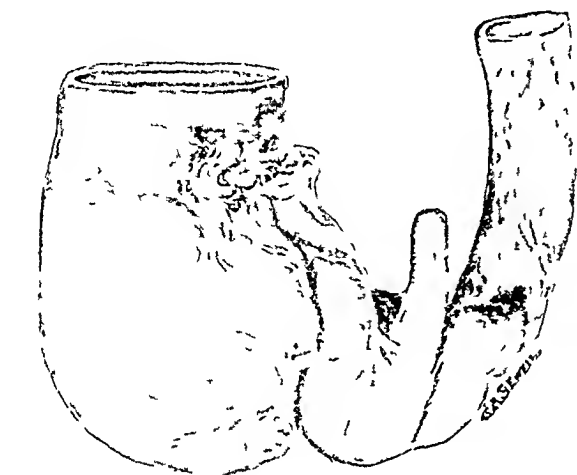


FIG 386 —VERMIFORM APPENDIX TIED DOWN BOTH TO CÆCUM AND ILEUM, AND DOUBLED ON ITSELF BY OLD STANDING ADHESIONS

The appearances in this illustration are very characteristic of what is frequently seen, but the case from which it was taken was a very unusual one. It occurred in a baby of seven days who was operated on for acute obstruction due to the adhesions which were old standing, and evidently ante-natal. The child died, and the cæcum was subsequently removed.

It may contain muco pus in its lumen, or the whole wall of the tube may be yellow with a diffuse purulent infiltration. The ulcer may gradually spread through the walls and lay open the peritoneal cavity, giving rise to a local or diffuse suppurative peritonitis, but the peritoneum may only be slightly affected, resulting in the formation of some fibrous adhesions.

*Necrosis* or *sloughing* of the appendix occurs in the acuter forms. It is due to an acute interstitial inflammation spreading from an impacted concretion, or from an ulcer of the mucosa, or results from kinking and thrombosis of the appendicular vessels in the meso-appendix. The whole appendix may slough, or merely a portion, and then usually the tip or the part immediately opposite the distal end of the meso-appendix. The necrotic tissue is soft and easily torn, of a blackish, brown, or green colour, and usually extremely offensive. It may be associated with a perforation,

through which the concretion may escape (Fig 387) In all these cases a grave peritoneal infection follows

(2) The **Peritoneal Phenomena** associated with appendicitis are of the utmost importance

In the milder cases the peritonitis is protective in type The serous coat of the appendix becomes inflamed, sheds its endothelium, and becomes roughened by a deposit of lymph, and this results either in a thickening of the wall, or in a formation of *adhesions* which tie down the appendix in various directions and positions Most commonly it is simply fixed to the cæcum along part of its length, but sometimes it is firmly united to it for its whole extent Adhesions may pass between the appendix and the omentum, or the mesentery, or ovary, etc , in fact, the appendix may be united to almost any of

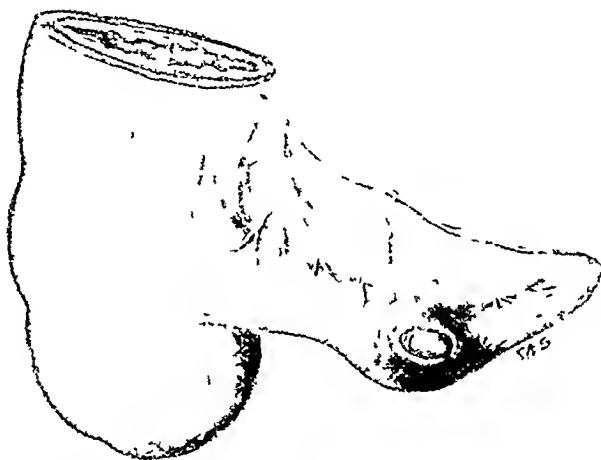


FIG 387—PERFORATION OF THE APPENDIX FROM AN IMPACTED CONCRETION, CAUSING AN ACUTE ABSCESS (SEMI DIAGRAMMATIC)

the viscera, and may thereby hamper their action or give rise to some form of acute obstruction It may also contract adhesions to the fasciæ, e g, over the psoas sheath or iliac vessels, and various symptoms may be caused thereby

In the graver cases an infective peritonitis occurs, and, according to the virulence of the organisms, the defensive powers of the patient, and the character of the infection, the process may be localized or not A *localized intra-peritoneal abscess* is by no means uncommon, its extension is limited by the formation of adhesions between the omentum, the parietes, and neighbouring coils of intestine Its exact anatomical relations depend on the original situation of the appendix Frequently it is located below and behind the cæcum, sometimes it burrows down into the pelvis, in other cases it passes inwards amongst the intestines, it may track up towards the liver either on the inner or outer side of the ascending colon The abscess may burst externally, and its approach to the surface will be heralded



by brawny swelling, redness and œdema, the most frequent sites for external pointing are the iliac fossa and the lumbar region. It may burst into any of the viscera, and then most commonly into the cæcum or bladder. Finally, it may break through the peritoneal adhesions, and involve the general serous cavity, causing acute diffuse peritonitis. The pus contained in the abscess is usually of a stinking character, and in cases of sloughing of the appendix the fœtor may be intense, but it must be remembered that the amount of smell is no gauge of the virulence of the process. Sometimes the débris of a broken-down concretion can be recognised in the pus. It is not always possible to recognise the appendix in these abscesses, even when it has not sloughed off, it may be firmly adherent to the cæcum, and unrecognisable to the examining finger.

*Acute diffuse peritonitis* occurs when defensive adhesions are not formed. A sudden perforation of an inflamed appendix may determine its onset, or it may occur in a patient with defective germicidal powers, when the local appendicular phenomena are comparatively mild. The infection is in the first place due to streptococci, and comparatively little effusion may be present. At a later date the *B. coli* may develop extensively, and mask the phenomena due to the streptococcal invasion.

(3) **Extra-peritoneal suppuration** occasionally follows, and is then usually due to extension backwards through adhesions formed between the appendix and the peritoneum on the posterior wall of the abdomen or pelvis, thereby leading to infection of the retro-peritoneal connective tissue. The pus may collect in the iliac fossa and point anteriorly, or may track downwards into the pelvis and open into the rectum, or may travel along the psoas tendon and open in the thigh, or burrow upwards into the loin, forming a perinephritic collection, or a retro-peritoneal subphrenic abscess, and then may even extend into the thorax.

(4) Various **complications** may be associated with any of these different types of appendicitis. (a) The veins in the meso-appendix may become thrombosed and infected with pyogenic organisms, detachment of emboli may lead to the occurrence of *pylephlebitis* and pyæmia. (b) *Thrombosis* of the femoral veins may occur, if on the right side, it is probably due to implication of the right iliac vein in the inflammatory process, but if it occurs, as is much more common, on the left side, it must be due to general toxic causes (p 343). (c) Chronic or subacute ovaritis often accompanies appendicitis in women, it is probably due to an absorption of toxins or bacteria along the lymphatics which accompany the arterial twig derived from the ovarian artery. (d) Various renal complications may supervene, usually from pressure of the inflammatory mass either on the renal vein or on the ureter as it crosses the pelvic brim, resulting either in hæmaturia or in renal colic. (e) Inflammation of an appendix located in a hernial sac is referred to hereafter (p 1065). (f) Lastly, intestinal obstruction may be induced by the acute inflammatory attack leading to paralysis of the intestinal wall, or

it may develop subsequently as a result of kinking or strangulation by bands or adhesions

**Clinical History**—(1) The mild variety of the disease, known as a simple catarrhal appendicitis, to which is added merely a localized plastic peritonitis, usually commences somewhat suddenly, the patient being seized with pain, which is at first referred to the umbilicus or to any part of the abdomen, but at the end of twenty-four to forty-eight hours localizes itself to the right iliac fossa. It is often of a sharp cutting character, but varies much in intensity and duration. Fever is usually present, and the attack may start with a rigor. The patient may complain of nausea and vomiting, but the latter symptom does not last long. Constipation results from the intestinal paralysis due to the inflammatory lesion, and in bad cases may be sufficiently severe and prolonged to constitute an attack of obstruction with faecal vomiting. In children it is sometimes replaced by diarrhoea, and that even blood-stained, so that the diagnosis may need to be made from typhoid fever.

On examination the abdomen is found to be held more rigid than usual, the right leg is often drawn up to relax the muscles, and in bad cases all abdominal respiratory movements are abolished. Even in mild cases the muscles over the right iliac fossa are held tense and rigid so as to guard the underlying structures. Definite tenderness is noted on pressure, and the patient will often, but by no means constantly, refer it to a spot about  $1\frac{1}{2}$  inches from the anterior superior iliac spine along a line drawn to the umbilicus (McBurney's spot). In many cases, where the appendix is directed backwards, there is marked tenderness in the lumbar region, but if it points downwards into the pelvis, there may be pain and tenderness on rectal or vaginal examination, which should never be neglected. A definite swelling may sometimes be detected by palpation, usually above the outer half of Poupart's ligament, but varying in its position with the site of the appendix, it may be dull on percussion, but is frequently tympanitic, since it consists of coils of intestine and omentum matted together around the appendix. The absence of a definite lump is due to the non-development of protective adhesions, and hence is noted in the worst cases of perforative appendicitis, or it may be caused by the inflamed mass lying deep in the abdomen, and being covered over by distended and uninflamed intestine.

This simple form of the disease usually lasts three or four days, and then, if properly treated, resolves satisfactorily without abscess formation. It is exceedingly common, and the prognosis is, on the whole, favourable. Tofft, of Copenhagen, found adhesions in the neighbourhood of the appendix in 35 per cent of all bodies subjected to post-mortem examination.

(11) The more serious variety, commonly resulting in a localized abscess, may commence in a similar way, but with more acute symptoms. There may be an initial rigor, and the temperature soon runs up, even to  $104^{\circ}\text{F}$ . Some general abdominal tenderness and distension follow, constipation is often absolute, and faecal vomiting may

occur. The muscles on the right side of the abdominal walls are held tense and rigid, and a well-marked fulness can sometimes be detected in the iliac fossa. In other cases a distinct swelling can be seen as well as felt, and is not necessarily limited to the right fossa, but may appear in the middle line of the abdomen or elsewhere. Under a careful régime this may disappear, and the symptoms gradually abate in their severity, the temperature and the pulse falling concurrently, but it is very common for suppuration to ensue, and such is indicated by the temperature persisting at its original high level, or by the pulse-rate increasing in rapidity, whilst the temperature falls. Fluctuation is rarely to be detected in the early stages, and, indeed, it is bad practice to wait for it before interfering, since there is a considerable probability that the tension within the abscess may be sufficient to break down the wall of newly-formed and not too strong adhesions, and the general peritoneal cavity may be thus infected. The abscess develops at first around the appendix, and is, of course, primarily intra-peritoneal. Not unfrequently it bursts into the bowel, and thereby relief is gained without the assistance of surgery, some authorities, indeed, maintain that this occurs in every case of the more severe type which resolves. In other instances it may point externally, either through the anterior abdominal wall, which becomes congested and œdematous as the pus approaches the surface, or through the loin, the pus having invaded the retro-peritoneal cellular tissue. In the latter case, it is sometimes found that the abscess burrows widely up and down the back of the abdomen, and may even extend behind and above the liver, constituting a subphrenic abscess. Not unfrequently it tracks up along the inner or outer side of the ascending colon, and then may get into relation with the under-surface of the liver. In other patients, and especially when the tip of the appendix lies over the brim of the pelvis, the pus travels downwards and forms a collection by the side of the rectum, the surgeon must never omit a rectal examination in appendicitis, where the temperature is of such a nature as to suggest the existence of an abscess, and yet no evidence of one can be found. Should it burst into the peritoneal cavity, all the phenomena of perforative peritonitis supervene, probably indicated by a sudden fall of temperature, followed by increased abdominal pain and distension. A fæcal fistula may result from the bursting or opening of any of these abscesses.

In not a few cases the patient's general symptoms improve after the first outbreak, the temperature may become normal, the pain decrease, and the vomiting cease. It is often difficult to be certain whether this improvement is merely temporary, or is the commencement of a true convalescence. Under the former circumstances, *i.e.*, if it is merely an *interval of quiescence*, careful examination will probably reveal some disturbing factor, either the abdominal distension persists, or perhaps hiccough is present, or a well marked, though localized, tenderness continues, perhaps only to be detected *per rectum*, or the pulse-rate may remain unduly high. After a few days the

temperature begins to rise once more, the focal symptoms become more urgent, and a subacute or chronic abscess forms

It is often by no means a simple matter to make certain that pus is present, but considerable assistance can be derived from a blood count, which is advisably made each day that the uncertainty persists. We would refer readers back to p 48 for a full consideration of *leucocytosis*, here we would merely repeat that a leucocyte count under 20,000 is merely indicative of an inflammatory attack well resisted, if suppuration is present, the leucocytes are usually over 20,000

A complication likely to occur in the more severe types of the disease is *pylephlebitis*, or infective thrombosis of the branches of the portal vein in the liver. Such would be indicated by recurrent rigors, and possibly by pain and tenderness in the hepatic area. Necessarily it is almost invariably fatal

(iii) **Diffuse Septic Peritonitis** is generally due to primary perforation or gangrene of the appendix, and only occasionally to rupture of a localized intra-peritoneal abscess. The onset is usually sudden, and may be followed by symptoms of collapse, from which the patient rallies in a few hours. The abdomen rapidly becomes distended and tympanitic, the muscular wall is held rigidly steady, constipation is absolute, not even flatus being passed, the patient suffers from persistent pain, which is generalized rather than local, and constant nausea and vomiting of the usual peritonitic type. The characteristic picture described at p 973 quickly develops, and death generally ensues in four or five days. ~~Fever is variable, and in the worst cases is absent, these afebrile cases,~~ in which reactive phenomena are defective, are often associated with a leucopenia

(iv) ~~Relapsing Appendicitis~~ is the term applied to a condition when an attack passes off, but not quite satisfactorily. There may be a slight persistent rise of temperature at night, or the appendix remains palpable and tender, or some amount of appendicular pain, often of a colicky character, may be noted. In many of these cases the symptoms are due to unhealed ulceration of the mucous lining or to stenosis of the tube. If left alone a more acute outbreak may supervene, or bacterial invasion of the vessels in the meso-appendix may follow, and serious consequences develop. If an attack of appendicitis does not clear up completely, an operation is always advisable for the removal of the organ

(v) **Recurrent Appendicitis** is characterized by repeated attacks of varying gravity in an individual who has been once the subject of the disease. They may occur only at prolonged intervals, or be so frequent as entirely to incapacitate the patient, and are usually associated with the presence of some abnormal adhesion or constriction of the appendix. It is not uncommon for the appendix to become fixed to the sheath of the *psoas* muscle, and then any excessive movements of the limb may light up an attack. Where stenosis exists, secretions containing bacteria may be pent up behind the constriction, and from time to time the patient suffers from severe pain of a colicky nature without fever, supposed to be due to an attempt

to get rid of the excess of mucus. Such attacks have been named *appendicular colic*. In a few cases the appendix becomes totally obliterated after a time and incorporated in a mass of adhesions, a natural cure being thus established, but more frequently, if these occurrences are allowed to continue, the patient finally develops an abscess, or succumbs to diffuse peritonitis.

Recurrences are more common after the simpler forms of the disease, and it has been calculated that over 30 per cent. of the subjects of a mild catarrhal attack suffer in this way. In the more acute forms recurrence is less common, and it is unusual for a case to recur when suppuration has existed, we have, however, seen cases where an abscess has developed two and even three times in connection with attacks which were separated by intervals of complete disappearance of symptoms.

**Diagnosis**—In a well-marked case the symptoms are so typical that the diagnosis can never be in doubt. The pain, tenderness, fever, vomiting, constipation, abdominal rigidity, and perhaps tumour, constitute a picture that is quite characteristic. The disease, however, often presents symptoms so varied, and manifestations so protean, that one is never surprised to meet with it in all sorts of diverse settings, and many mistakes of diagnosis are made, even by the most skilled clinicians.

Recurrent appendicular pain may be mistaken for that of *renal colic* or for the painful attacks associated with displacement of a floating kidney (*Dietl's crises*), or *vice versa*, and the difficulty is increased if hæmaturia or irritation of the bladder are caused by an appendicitic effusion or abscess. *Biliary colic* may be simulated, whilst a *distended and inflamed gall-bladder* may closely resemble an appendix abscess which has travelled upwards.

*Perforation of the duodenum* or even of the *stomach* may lead to symptoms very similar to those of appendicitis, due to the inflammatory mischief tracking downwards. The initial pain will usually be referred to the upper part of the abdomen, and there may be evidence of free gas in the peritoneal cavity. If gas escapes from the abdomen on operation, and it is free from odour, the probability is that the lesion is gastric or duodenal. *Mucous colitis* simulates appendicitis, and the appendix is indeed often involved in the mischief. The distinction is made by the tenderness being located over the whole course of the colon, and by the passage of mucus in the stools. *Tubal* and *ovarian* diseases are recognised on pelvic examination, but the fact must not be overlooked that chronic appendicitis is often associated with inflammation of the right ovary, and that attacks of pain often occur at each menstrual period.

A considerable swelling in the right iliac fossa may result from repeated attacks due to a matting of the parts together, and a diagnosis from tuberculous or malignant disease is often difficult apart from operation. The history may be spread over a longer time, however, in appendicitis.

In abdominal abscesses the possibility of an appendicular origin

must always be kept in mind, as they may present in any part of the abdomen, and it is often only by a careful exploration of the cavity that we can trace the cause to the appendix.

The diagnosis from acute obstruction is noted hereafter (p 1108)

The **Prognosis** is never absolutely certain, for, as has been well pointed out by many acute observers, the initial symptoms are frequently alike in all the varieties, and hence one can never know what course the case is going to take, as R Morris, of New York, says, 'The infected appendix is a cap which sometimes snaps, sometimes flashes, and sometimes causes an explosion, and none of us can tell in advance just what is going to happen' As particularly bad signs may be mentioned a continued high temperature, in spite of rest and careful dietetic measures, or a fall of temperature with increased rate of the pulse Persistent hiccough is also a bad sign. The existence of a swelling in the iliac fossa is not a bad sign, but rather the reverse. Absence of a localized swelling is due either to a defective formation of protective adhesions, and hence is likely to be noted in the most acute cases, or to the appendix being placed behind the cæcum in a position less favourable to operative measures.

**Treatment**—So much has been written on this subject during the last twenty years, that it is extremely difficult to compress even a brief summary of the many facts observed into a necessarily limited space. Formerly perityphlitis was the exclusive property of the physician, but a great change has occurred, and many authorities consider that appendicitis is more justly within the realm of the surgeon, or, at any rate, that a surgeon should always share the responsibility of treatment with the physician. At any moment complications may develop even in what appear to be simple cases, in which immediate surgical assistance will alone hold out any hopes of saving the patient. In America surgery is the recognised treatment for almost every case of the disease, as soon as it is diagnosed, in this country more conservative ideas still persist, but we are glad to note that a more healthy opinion is gaining ground, and that surgical interference is becoming recognised as the most appropriate means of treatment in many instances. At the same time, we are bound to admit that operation during the acute stage does not seem to us to hold out such good prospects as when performed during the quiescent period after an attack, and hence if the patient's safety is not compromised by delay, one would prefer to postpone operation till the acute symptoms have passed away.

1 In the mild catarrhal type of appendicitis, where the temperature does not run above  $101^{\circ}$  and the symptoms are not severe, all that is required in the majority of instances is to put the patient to bed, and apply fomentations locally, the lower bowel should be emptied by an enema, and if it seems likely that there is an accumulation of irritating fæces within the intestine, one dose of castor oil or of calomel may be administered. A fluid, unstimulating diet is all that is permitted, and should there be much vomiting, rectal alimentation may be resorted to. Possibly morphia may be given with

advantage to quiet the patient and check peristalsis, thereby facilitating the formation of protective adhesions, but the less the better, since it tends to mask symptoms

The question of operation for this mild type of disease can be readily compressed into the three following propositions

(a) If the condition is not showing signs of improvement at the end of forty-eight hours (*i.e.*, on the third day) in spite of appropriate treatment, operation is desirable

(b) If the appendix remains tender and palpable after an attack, and especially if the temperature rises slightly at night, the organ should be removed without delay

(c) As soon as the attack is really quiescent—*i.e.*, generally in nine to ten days—the appendix should be removed. This proposition may not be generally accepted, but it is absolutely logical, and daily experience is emphasizing the conviction as to its accuracy. In the first place, recurrence is common, and the figures given above (*viz.*, 30 per cent) probably under-estimate its frequency. Then, too, it is impossible to tell which cases will recur and which escape, whilst the recurrent attack is frequently more severe than the first, and we have often known the second or third attack complicated by suppuration. Moreover, each recurrent attack is likely to add to the adhesions present, so that whilst removal after a first attack is an easy proceeding, removal after many recurrences may necessitate a long incision and a troublesome and dangerous dissection, complicated, perhaps, by unintentional perforation of the bowel, or even enterectomy

**Operation in the Quiescent Period**—The muscle-splitting plan suggested by McBurney may well be adopted when it is probable that but few adhesions are present. The incision is an oblique one about 2 to 3 inches long, crossing McBurney's spot or a little below it, and parallel with the outer end of Poupart's ligament, somewhat similar to that for ligaturing the external iliac artery (Fig 363, C). The external oblique is exposed, and incised in the course of its fibres, the divided segments are held well aside by retractors, so that about 2 inches of the internal oblique muscle come into view. The muscle fibres in this region will run nearly transversely, and both it and the transversalis muscle can be divided by a transverse incision. The introduction of large deep retractors will expose a square or diamond-shaped area of subperitoneal fat or peritoneum about  $1\frac{1}{2}$  to 2 inches in diameter. The peritoneum is divided by a transverse incision, and the margins grasped for identification purposes by Spencer Wells forceps. The cæcum will probably present, and is gently withdrawn. The anterior longitudinal muscular band conducts to the appendix, which is freed from adhesions and removed. The meso-appendix is first divided after securing the vessels in it with a ligature (Fig 388, A). The serous and muscular coats are then divided by a circular incision and peeled back like a cuff, leaving the mucous membrane as a narrow tube (Fig 389). The retraction is carried back so as to enable a catgut ligature to be placed around the tube

of mucous membrane flush with the cæcum. The distal end is grasped with Spencer Wells forceps, and cut away after protecting the parts below with a strip of sterilized gauze (Fig 390). The protruding portion of mucous membrane is carefully curetted, and the sero muscular cuff replaced over it and secured by a ligature (Fig 391). If this proceeding is carried out carefully, and the mucous membrane secured flush with the cæcal wall, there is no more need to touch it with pure carbolic or the actual cautery (as is sometimes recommended) than in any other operation on the intestine.

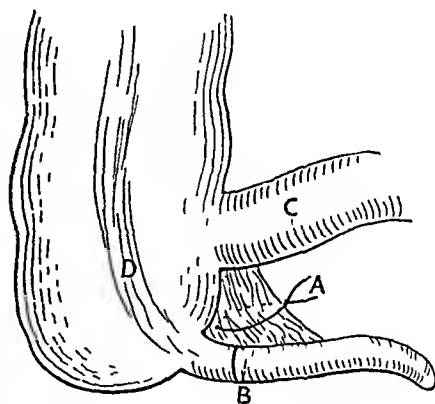


FIG 388—APPENDECTOMY

A indicates the ligature placed on the meso-appendix, B, the situation of the circular incision through the sero muscular coat, C, the lower end of the ileum, D is placed on the anterior muscular band of the cæcum which leads directly to the base of the appendix.

All bleeding points having been secured, the cæcum, which has been protected during the operation by a warm wet sterilized cloth, is returned into the abdomen, and the incision in the parietes closed layer after layer by catgut sutures. No drainage is needed.

If, however, it seems probable that many adhesions are present,

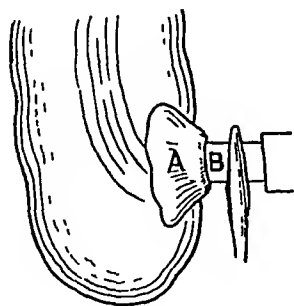


FIG 389

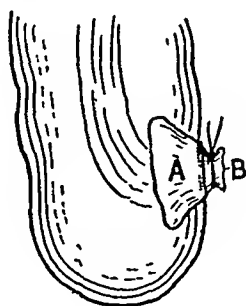


FIG 390

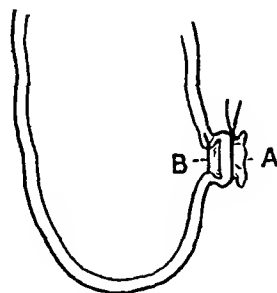


FIG 391

#### AMPUTATION OF THE APPENDIX

In Fig 389, A represents the cuff of sero muscular tissue dissected up, exposing (B) the tube of mucous membrane, which is secured by a pair of Spencer Wells forceps.

In Fig 390 the tube of mucous membrane (B) has been ligatured close to the cæcum, and the appendix cut away proximal to the forceps.

In Fig 391 the ligatured mucous membrane (B) is covered in by the sero muscular cuff (A), which is itself closed by a ligature.

the muscle-splitting operation should be avoided, and the abdominal parietes divided in the line of the cutaneous incision, so as to allow



the wound to be enlarged up or down as may be desired. The severance of these adhesions may be a most tedious and troublesome procedure, but when once it is effected the appendix is amputated as described above. In some of these more serious and prolonged operations, it may be desirable to drain the iliac fossa by a tube or gauze wick for a short time.

Under any circumstances the patient lies up in bed for three weeks to allow the bond of union to become firm, and should avoid all needless strain for some months.

2 In the gravest variety of *fulminating appendicitis*, associated with general septic peritonitis, there can be no question that the only hope of recovery lies in immediate operation. When the symptoms of diffuse peritonitis are well marked, this hope is but slender in the extreme, if, however, one can anticipate the general diffusion of the mischief, it is possible that a certain percentage of the cases may be saved. Hence, whenever the attack starts with severe pain and collapse, and if the abdomen shows any signs of rigidity or distension in twenty-four hours, and if vomiting is present, no time should be lost in operating. The abdomen is opened, either through the middle line or in the right iliac fossa, the effusion is swabbed or washed away with sterilized salt solution at  $108^{\circ}$  F, and the appendix looked for and removed. Drainage must then be provided by tubes or gauze wicks: one tube passes into Douglas's pouch, and one through the lumbar region, gauze wicks are inserted amongst the intestines.

3 When an abscess is evidently present, being indicated either by fluctuation or by a commencing œdema of the abdominal wall, there should be no hesitation in cutting down. An incision is made over the œdematous spot, and deepened carefully, since the tissues are probably matted together, and cut like bacon or brawn. The knife or index-finger may suddenly sink into the abscess cavity, and a gush of fœtid pus follows. The cavity is gently explored, so as to ascertain whether or not the appendix can be felt, no undue force should be used, for fear of breaking down adhesions and thus opening the general peritoneal sac. If the appendix cannot be readily found, it is best left alone, the abscess is thoroughly irrigated, drainage is provided for, and the incision partly closed. Probably the case will go on well, the discharge losing its smell about the third day, and the remaining sinus will gradually heal by granulation. Should the appendix, however, present itself, it should be removed.

4 There is still, however, a large group of cases in which neither of the above conditions is manifest, and yet the symptoms, both local and general, point to the fact that a lesion of considerable gravity is present. Some difference of opinion exists as to the necessity for operation in these cases. We are quite ready to admit that in many instances conservative or medical treatment will suffice to bring about a satisfactory result, but this can never be depended on, and, unfortunately, only too many lives have been sacrificed through

an unwillingness to call in a surgeon, except at the last moment. Under these circumstances, even if acute peritonitis has not occurred, the patient is profoundly toxæmic or exhausted by preceding suffering, and hence operative measures are likely to fail through the asthenic condition of the individual, even if the local phenomena are such as can be efficiently dealt with. Personally, we are distinctly in favour of early operation, and the general rule (to which, of course, there are exceptions) which we should suggest as justifiable is that, *if in spite of suitable rest and medical treatment the symptoms, both general and local, are not commencing to abate at the end of forty-eight hours, operation should be undertaken.* The great advantages we would claim for this procedure are (a) That the patient is not in a state of collapse from toxæmia, and hence can stand the shock of an intra-peritoneal exploration without much risk, (b) that the appendix can usually be found, isolated, and removed without much difficulty, (c) that the risks associated with the presence of pus in the abdomen during this procedure are considerably diminished, since but little pus is likely to have developed at so early a date, and (d) that a smaller incision will be required, and hence there will be less likelihood of a hernia developing subsequently. The following conditions indicative of an intra peritoneal abscess, even if no tumour can be felt, always suggest that an operation is desirable, viz., a leucocyte count above 20,000, especially if maintained for twenty four hours, persistent distension of the abdomen, a maintained high temperature, hiccough, or a continued high pulse-rate in spite of a falling temperature.

*Operation for Suppurative Appendicitis*—The incision must vary somewhat with the physical signs and the site of maximum tenderness. The whole thickness of the abdominal wall is divided, and it is well to make a sufficiently large opening rather than one that is too small, an extra inch of incision may make all the difference between blindly groping in the dark and seeing clearly what one is doing. The general arrangement of the parts is noted, and the peritoneal cavity protected from purulent infection by packing in sterilized gauze, one strip is usually passed upwards along the ascending colon, one downwards into the pelvis, and one internally to protect the small intestines and general serous cavity. The cæcum is then gently lifted from its bed, and the abscess will usually be found behind it. The procedure, of course, must be modified with the actual condition of affairs, but every effort must be made to prevent soiling of the unaffected peritoneum. Whenever possible, the appendix should be removed, it is first freed from adhesions, and the meso-appendix ligatured. If sufficiently healthy, a formal amputation, as in the chronic cases, should be undertaken, but such a procedure is often impracticable. A silk thread is then tied around the base about  $\frac{1}{2}$  inch from the cæcum, and the appendix cut away, the stump is, if practicable, buried by the insertion of two or three sutures into the serous membrane covering the cæcum. Not unfrequently, however, the appendix does not present, and then

it is usually wiser to leave it alone. The cavity is emptied of pus by swabbing it out, and then carefully packed in such a way as to drain it thoroughly, and yet to protect the surrounding parts. It may be desirable to introduce a drainage-tube through a counter opening in the loin. The abdominal incision is partially closed.

The packing is gradually removed in the next two or three days, and after the general cavity has been shut off by the development of adhesions, irrigation with salt solution is permissible. The wound heals by granulation, and when nearly flush with the surface may be drawn together by strapping, so as to limit the chances of development of a ventral hernia.

**Sequelæ** — A *Fæcal Fistula* may result from a perforative appendicitis when the abscess has been merely opened, and no radical treatment undertaken at the same time, or it may follow an amputation of the appendix from sloughing or yielding of the stump. It is usually small in size, and sinuous in its course, and may in many cases close of itself. Occasionally it is necessary to deal with it by laying bare the cæcum in the iliac fossa, and removing the appendix or suturing the opening. Failing that, it may be necessary to short-circuit the cæcum.

A *Ventral Hernia* sometimes follows from the yielding of the cicatrix in the abdominal wall after an abscess has been opened and drained. Both omentum and bowel, perhaps matted together and adherent to the cicatrix, are found in the protrusion. In some cases it may suffice to cover it with the concave pad of a truss, but in others operation is required, adhesions must be divided or broken down, and often the opportunity can be taken of removing the appendix, if this has not already been accomplished. The margins of the divided muscles are then sought for, and united by a row of buried sutures in the ordinary way.

### Affections of the Liver

**Rupture of the Liver** is produced by injuries to the abdominal walls, such as blows, kicks, or crushes, or it may be torn by the broken end of a rib. Penetrating injuries also occur, as from sword or dagger thrusts, and the organ may be involved in a gunshot wound. The resulting lesion varies considerably, the gland may be merely torn or contused from a non-penetrating blow, or freely incised by a sharp cutting implement, in which case some of the larger venous trunks are likely to be divided, a bullet sometimes produces almost total disorganization. The amount of injury depends, to some extent, on the condition of the organ, if it is firm and sclerosed, it may receive little damage from a blow which would otherwise do it considerable harm, whilst if it is enlarged and fatty, it is readily torn.

The chief **Symptoms** are shock, which is often not very excessive, pain and tenderness in the right hypochondrium, and the evidences of loss of blood. The last is, perhaps, the most important, and upon its severity depends to a large extent the result. Sometimes the

capsule remains intact, and then, although there is considerable intra-glandular ecchymosis and laceration, no free blood escapes into the peritoneal cavity. Such a lesion is not unlikely to be followed by an abscess of the liver. When the capsule is torn, intra-peritoneal hæmorrhage is sure to ensue, if slight, the patient, though suffering from all the phenomena characteristic of loss of blood, may recover, the blood being absorbed, and the wound in the liver cicatrizing. This process is usually attended by a certain amount of jaundice and some vomiting, whilst the urine is also tinged with bile-pigment. Well-marked pyrexia may follow the initial shock, and the abdominal wall is held rigid. In other cases, the blood collects at first in the upper part of the abdomen, but gradually extends downwards, if the bowel is uninjured, recovery may ensue, but not uncommonly there is some associated contusion of the gut wall, through which intestinal bacteria find their way, giving rise to a localized or general peritonitis. Of course, in the more severe lesions, where perhaps the left lobe is entirely torn off or a portion hopelessly contused, death from hæmorrhage is almost certain to ensue in a very short time.

The **Diagnosis** of hepatic rupture turns mainly on the history of the accident, the situation of the blow, and the resulting symptoms. Evidences of intra-peritoneal bleeding, associated with pain in the right side, are extremely suggestive. It must not, however, be forgotten that the passage of a hansom cab or other vehicle over the body may give rise to much shock, and to considerable local pain and tenderness, and yet no serious mischief need have happened to the liver.

The **Treatment** in the more simple cases consists merely in careful expectancy, the surgeon holding himself in readiness to interfere should any untoward symptoms supervene. The patient is kept quietly in bed, ice may, if necessary, be applied to the side, the diet is limited to fluids, and the bowels emptied by enemata. In the more serious cases, where the diagnosis of ruptured liver is tolerably certain, an exploratory laparotomy should be undertaken, and an attempt made to deal with the wound. Possibly a median incision is as good as any, since the left half of the liver often bears the brunt of the injury. Outlying ragged portions of the gland may be totally removed, preferably by the cautery, though one usually has to depend upon plugging the wound with gauze in order to effect hæmostasis. Clean linear cuts may be sutured with silk, but there is considerable difficulty in preventing the stitches from tearing out of the friable hepatic tissue, it is wise to insert all the stitches first, taking up a good margin of the gland substance before attempting to tie any. The wound is then carefully closed by the fingers, and the sutures slowly and gently tightened. Very shallow wounds which it is impossible to stitch or plug satisfactorily may be seared with the cautery so as to stop bleeding, and then a gauze drain is placed over them, and brought out of the external wound.

**Abscess of the Liver** is due to a variety of causes.

1 *Multiple Abscesses* develop in cases of pyæmia, whether the emboli are carried by the hepatic artery or by the portal vein. In

the former case, the condition arises as a complication of general pyæmia of systemic origin, in the latter, the originating focus of mischief is located in the area of distribution of the portal vein—*i.e.*, in the intestinal canal. Thus, pyelephlebitis, as it is termed, is not uncommonly met with in appendicitis, and sometimes in typhoid fever, whilst suppurating piles may also lead to it.

2 *Suppurative Cholangitis* is another cause of multiple abscess of the liver. It consists of an inflammatory affection of the biliary ducts and passages, and is due to the spread of organisms from the intestine, or occasionally from the gall-bladder after an operation. The biliary ducts in the liver become enormously dilated, and filled with a mixture of bile and pus which looks very like yellow ochre. It is accompanied by pain over the gland and the general phenomena of pyrexia, but rigors are not present. The patient is not usually jaundiced, but bile may be found in the urine. Treatment is of little avail, but if a diagnosis can be made, and the gall-bladder has not been already incised, it may relieve tension to open and drain it.

3 Hydatid cysts may suppurate, and require treatment as for an abscess of the liver.

4 The more important abscesses, from a surgical standpoint, are those which, from their size, demand operative treatment. They may result from traumatism in the way stated above, or may arise in connection with hydatid cysts, but more commonly are of the type known as *tropical abscess*. The latter usually occurs in individuals who have travelled in the tropics, and 75 per cent of the cases are attributed to dysentery. The exact mode of causation has not yet been fully worked out, but it seems probable that they are primarily of embolic origin. They are most frequently situated at the back of the right lobe, but, of course, any part of the viscus may be involved. Though often single, the cavity is frequently loculated, indicating that several original foci of suppuration have united together. Any of the ordinary pyogenic organisms may be found within them, and not unfrequently the *B. coli* is present. In a few cases the *Amœba coli*, an organism which is found in the bowel in some forms of dysentery, has been discovered. Occasionally the pus is sterile, the causative organisms having probably been disposed of, possibly as a result of the chronicity of the process. The abscess wall consists of disintegrating hepatic tissue in acute cases, but may have a fibro-cicatricial wall in the more chronic forms, and in an old-standing abscess the limiting membrane may be as tough as leather. The pus is sometimes of the ordinary type, but not uncommonly reddish-brown in colour, somewhat like chocolate, and of a most nauseating odour.

The **Symptoms** are in some instances extremely slight, the patient perhaps dying of peritonitis due to its rupture without its presence having ever been suspected. The individual usually complains of a sense of weight and fulness in the right hypochondrium, and in the more acute cases this may be accompanied by severe pain and localized tenderness over the whole hepatic region, the pain being also referred to the right shoulder. A certain amount of febrile dis-

turbance occurs, the degree of which depends on the rapidity of formation of the abscess, in the more acute forms the temperature is high and rigors may be present. The pyrexial phenomena are associated with loss of appetite, rapid and well-marked emaciation, and perhaps a certain amount of icterus, though the latter is not usually a prominent phenomenon. On physical examination a more or less evident enlargement of the liver will be detected, with, perhaps, a feeling of elasticity, or even of fluctuation at some spot. The dulness often extends up towards the thorax rather than downwards, though when the abscess is situated not far from the free margin of the liver, this is not the case. A doubtful diagnosis can sometimes be confirmed by the aspirator or hypodermic needle, but this should not be utilized unless one is fully prepared for immediate operation in the case of pus being found. Manson directs that the aspirator needle should be introduced in the following situations (1) In the right axillary line through the seventh or eighth costal interspace, (2) just below the ribs in the right nipple line, (3) immediately below the lung in the line drawn downwards from the angle of the right scapula.

Left to itself, several distinct courses are open for the abscess to follow. It may become adherent to the anterior abdominal wall and point in the epigastrium, its onward passage being indicated by congestion and œdema of the parietes, it may open into the peritoneal cavity, or into one of the hollow viscera, such as the colon or duodenum, or, again, it may travel upwards, burrowing through the diaphragm, and either bursting into the lung, its contents being expectorated, or into the pleural cavity, leading to an empyema. Occasionally it remains passive as a chronic encysted abscess, and then the walls become very thick. One of us recently opened an hepatic abscess which had been diagnosed by a hypodermic needle twelve years previously, and left alone. It contained about 2 pints of pus, and the walls were fully  $\frac{1}{2}$  inch thick. The patient came under observation because the swelling was becoming more prominent, as the result of increased intra-abdominal pressure, due to pregnancy.

**Treatment** — *Aspiration*, repeated once or twice, has been frequently employed, but is of little value, and not a few cases are on record in which septic peritonitis or pleurisy has followed the introduction of the needle from the front or side respectively. Experience proves that the usual law of treating suppuration ought to be strictly obeyed, viz, that the abscess should be opened and drained. If pointing in front and adherent to the parietes, there is no difficulty or danger in making an incision over the most prominent spot and laying the cavity open, it is then well flushed out and a drainage-tube inserted. If on dividing the abdominal parietes it is found that the liver is not yet adherent, it was formerly thought best to plug the wound with sterilized or antiseptic gauze, or to introduce sutures between the liver and the parietal peritoneum so as to determine the formation of adhesions to such an extent as to shut off the general peritoneal cavity, in a few days the abscess could then be opened with safety. At the present time the operation is done at one sitting with precautions of

a similar type to those taken in dealing with an intra peritoneal abscess connected with appendicitis. The general serous cavity must be carefully protected by sterilized gauze before letting out the pus, and the assistant must keep the parietes in close contact with the hepatic tissue. It may be possible to insert a few stitches through the liver substance, securing it thus to the parietal peritoneum, otherwise one must trust to careful packing. After opening the abscess, it is usually advisable to wash it out, and this may with advantage be repeated subsequently. A large drainage-tube is inserted, and packed around with gauze to prevent purulent extravasation.

When the abscess is in its most common situation, viz, the back of the right lobe, it is often most satisfactory to open it from the side, a similar proceeding is sometimes needed when an abscess has been opened from the front, and does not drain properly. An incision is made a little behind the mid axillary line through the ninth or tenth intercostal space, and a portion of one of the adjacent ribs removed. The pleural cavity is opened, and the costal pleura stitched carefully to that portion which covers the diaphragm, it will be found that this structure lies nearly vertical in this position, and but little difficulty is experienced in shutting off the general pleural cavity. The diaphragm is then divided, and not unfrequently the peritoneal cavity is opened, it must be carefully protected by gauze packing, and then the liver incised, less commonly adhesions may have already formed, or a bare area of the liver may be found, through which the pus can be withdrawn and the abscess opened.

**Hydatid Cysts** occur in the liver more frequently than in any other part of the body. For general details as to the life-history of the *Tænia echinococcus* and the structure of hydatid cysts, see p 220. They produce a localized painless enlargement of the liver, the cysts varying in size from a small marble to a child's head, the outline is well defined if superficial, but not so if placed deeply, the cavity is usually filled with fluid and daughter-cells. Fluctuation may be distinguished, and a hydatid fremitus or thrill (arising from the concussion of the contained daughter-cysts) may, it is said, be elicited on palpation. The diagnosis is easily made if the cyst projects from the lower border, but when deeply embedded in the organ it may be exceedingly difficult, and the tumour can only be distinguished with certainty from carcinoma or syphilis by the use of the aspirator, or preferably by an open exploration. The character of the fluid with drawn from a hydatid cyst is at once conclusive, as it is of low specific gravity, viz, 1007 to 1009, slightly opalescent, with no albumen, and a trace of salt, the presence of scolices or hooklets is the pathognomonic feature.

**Terminations** — The cyst may remain latent and innocuous, or may actually dry up and form a mass somewhat like wet mortar, owing to the death of the organism, or it may burst and be evacuated in different directions, with or without suppuration. Thus, it may open externally through the abdominal parietes, or into the peritoneal

cavity, causing fatal shock and in many cases peritonitis, or into the stomach or intestines, spontaneous cure usually resulting, or it may penetrate the diaphragm, and the contents be expectorated, or set free in the pleural cavity, causing a rapidly fatal pleurisy. It has been known to open into the pericardium, or even into the hepatic veins, the contents then being impacted in the right auricle, in both cases immediate death resulted.

**Treatment** —The best plan of dealing with a hydatid cyst is to lay it open either through the anterior abdominal wall, or through the costal parietes and diaphragm, to empty it of its contents, and if possible to enucleate the lining wall or endocyst, which is often but loosely connected to the fibrous ectocyst. This is usually accomplished at one sitting. Similar precautions as to protecting the peritoneum are taken as for an abscess. When the surface of the liver is exposed, it is advisable to puncture the cyst first with a trocar and cannula, so as to reduce the tension within it. It is then incised freely and the loose daughter-cysts removed. This is facilitated by flushing out the cavity with sterilized salt solution. The endocyst is removed either by enucleation with the fingers or a blunt dissector, or it may be possible to detach it by irrigation, the nozzle of the irrigator being inserted beneath it. If enucleation is completely successful, a gauze packing is introduced into the cavity thus formed, and cicatrization is allowed to proceed. If, however, part of the lining wall is left, a drainage-tube must also be introduced, and the cavity subsequently irrigated at each dressing.

No attempt should be made to remove the fibrous ectocyst, as it is closely connected with the liver substance, and grave hæmorrhage might follow any interference with it.

Formerly *aspiration* and *electrolysis* were largely employed in the treatment of this affection. It has been found, however, that although a considerable percentage of cases could be cured in this way (more than a half), yet that it was not unaccompanied by risk of peritonitis, and that recurrence was often observed. Moreover, some of the fluid not unfrequently leaked into the peritoneal cavity, and probably from the absorption of some toxic product present led to urticaria, and sometimes to even graver phenomena of poisoning. Electrolysis merely acts by producing a puncture of the cyst wall and consequent leakage. Both of these methods should be entirely discontinued.

A suppurating hydatid cyst is dealt with according to the same rules of treatment as hold good for abscess of the liver.

**Tumours of the Liver** are rarely primary. Secondary sarcoma and carcinoma are by no means uncommon, but of course nothing can be done for them. A few cases are on record of removal of a tumour or gumma together with a portion of the tissue of the organ, but such must necessarily be a matter of such rarity that we cannot spare space to discuss it.



### Affections of the Gall-Bladder and Biliary Passages

**Rupture of the Gall-Bladder** results from such injuries as blows, crushes, kicks, etc., whilst it may also be produced by penetrating wounds or bullets, occasionally it may follow ulceration from within, as from a large impacted gallstone. Blood and bile are in consequence extravasated into the peritoneal cavity. Pure bile is sterile, but if any inflammation of the biliary passages has been present, organisms are sure to have found their way into the gall bladder, and thus complications may readily ensue. If a considerable quantity of bile escapes suddenly into the peritoneal sac, acute peritonitis is certain to follow, whether organisms are present or not, owing to the irritating nature of the fluid, jaundice is also developed from absorption of bile by the peritoneum, and it may also be found in the urine. A more gradual escape of the secretion will probably lead to the formation of a localized intra-peritoneal abscess or collection of fluid, associated with jaundice and probably clay-coloured stools. In a penetrating wound bile and blood will escape on the surface, and septic peritonitis is almost sure to follow.

The immediate **Symptoms** are those of shock and severe hypochondriac pain, and this will be succeeded by either acute peritonitis or by the formation of a localized intra-peritoneal swelling, together with jaundice. When the existence of such a lesion is suspected, **Treatment** always consists in an exploratory laparotomy. The fluid within the abdomen is removed with swabs or washed away, and the gall-bladder carefully examined. Should only a small injury be found, it is perfectly feasible to close it by sutures, a gauze wick should, however, be passed down to the lesion for a few days, so as to provide a means of drainage should leakage occur. A more serious rupture will necessitate removal of the gall-bladder, or else the margins of the wound may be stitched to the abdominal parietes, and a biliary fistula thus produced. Should the common bile-duct be entirely divided, the ends should be closed by sutures and a cholecyst-enterostomy undertaken, a small wound in the duct may be sutured.

**Cholelithiasis** is the term applied to the presence in the gall-bladder or biliary passages of **Gallstones**. These consist mainly of crystals of cholesterine, held together by mucus and coloured by the bile-pigment, they are soluble in chloroform. When first passed and moist, their specific gravity is a little higher than that of water, and hence when immersed in it they sink, after drying, however, they are found to float. The number present varies immensely, sometimes a single large one exists, which is more or less barrel-shaped (Fig 392), more frequently they are multiple, scores or hundreds being present, and are then usually faceted, and with a satin like yellowish lustre. If they have lain long in the gall-bladder, they are usually of a deep brown or almost blackish colour.

The **Origin** of gallstones is not yet fully understood, but there seems no doubt that they are primarily due to an inflammatory condition of the wall of the gall-bladder or biliary passages, the cholesterine being

formed by the lining epithelium. Their usual location is the gall-bladder or the lower biliary passages, but they can also develop in the ducts within the liver, especially in cases where the hepatic derangement has been of long standing. They occur most commonly in women who have suffered from dyspepsia and constipation, and may be associated with cancer, either as cause or effect. In a case dealt with by one of us, the origin of the trouble seems to have been the swallowing of a pin many years previously, which worked its way into the gall-bladder, set up an inflammation which resulted in the formation of calculi, and only appeared again after a successful operation, when sixty-six stones had been removed.



FIG. 392.—VARIOUS TYPES OF GALLSTONES

Those on the left are of the usual type—not of great size, and faceted—that on the right was a large stone a little less than the actual size, removed from the cystic duct of a patient who also had carcinoma of the hepatic flexure of the colon.

The **Symptoms** produced are extremely variable. The fact that they are frequently found unexpectedly in the post-mortem room suggests that they may remain latent for years, and only cause trouble when attempting to escape, or if associated with some inflammatory disturbance. Their occurrence is usually preceded by dyspeptic phenomena, which have perhaps lasted for years, and by constipation. Some pain is complained of in the right hypochondrium, but possibly nothing very serious is noted, until a physical examination reveals the distended gall-bladder, which forms a tumour projecting from under cover of the ribs, usually the 8th or 9th, and tending to enlarge downwards towards the umbilicus; it is usually firm elastic, and perhaps fluctuating, it moves with the liver during respiration, and there is never intestine in front of it. Such a condition often yields to medical treatment, the diet has to be carefully regulated, and a sufficient amount of exercise ordered. Alkaline purgative medicines

are usually employed, and a well-to-do patient may be sent to Carlsbad to drink the waters. Possibly massage may be utilized to assist in the extrusion of the calculi, and drinking considerable quantities of olive oil is said to be beneficial in effecting the same object.

There are several complications, however, which may call for surgical treatment.

1 Inflammatory phenomena connected with the gall-bladder (*cholecystitis*) may assume considerable proportions. Acute inflammation is usually due to infection with streptococci or the *B. coli*, which travel up the biliary passages from the intestine. It may also arise apart from gallstones, especially during an attack of typhoid fever. It is evidenced by acute pain and tenderness in the right hypochondrium, together with vomiting, constipation, and fever. The constipation may be of such a marked character as almost to amount to obstruction, and arises mainly from paralysis of the neighbouring coils of gut, *e.g.*, the duodenum and transverse colon. The abdominal wall is held rigid and tense, but the enlarged gall-bladder may be detected beneath it. In one case it was nearly as large as a coconut, and on exposure was of a brilliant red colour, and contained about 8 ounces of muco-pus. It was absolutely free from adhesions, and there were two gallstones within, one of them embedded in the oedematous wall. The abscess may burst externally or into the peritoneal cavity, or possibly into one of the hollow viscera. Sloughing of the gall-bladder wall occasionally happens, and the symptoms are then always extremely grave. In other cases the inflammation subsides after a time, but results in a considerable development of adhesions which interfere with operative proceedings, and may also determine an attack of intestinal obstruction. Should the inflammatory mischief extend up the hepatic duct into the liver substance, diffuse *suppurative cholangitis* will result, and may lead to a fatal issue. A condition of chronic peritonitis is likely to follow whenever calculi remain lodged in the gall-bladder for some time.

2 *Biliary colic* is another most distressing complication, due to the onward passage of gallstones along the ducts. The pain is of a most acute character, doubling the patient up, and causing considerable shock; it radiates from the right side, shooting over the scapular region and into the back, it commences abruptly, and continues in paroxysms accompanied by vomiting until the stone is either discharged into the intestine or slips back into the gall-bladder, leading to a sudden cessation of the pain, a sense of tenderness and discomfort may, however, persist for some time, and possibly a little jaundice, owing to the swelling of the mucous membrane obstructing the passage of bile. These attacks sometimes come on at more or less regular intervals, and may be so frequent as to produce great exhaustion. At the time, they should be treated by the application of fomentations to the side, and the administration of opium, sometimes a large dose of olive oil by the mouth may assist in the passage of the stone, but if they recur at all frequently, cholecystotomy must be undertaken.

3 A gallstone does not always escape into the bowel, it may become *impacted*, and then gives rise to a train of tolerably characteristic symptoms, which vary somewhat with the site of obstruction. If the *cystic* duct is blocked, there is severe pain in the side, and perhaps distension of the gall-bladder with mucus (*hydrops*), constituting a tumour which can be felt, but there is no jaundice. If the calculus is lodged at the *junction of the common and hepatic ducts*, there will be intense icterus, but the gall-bladder is not necessarily distended, the liver, however, is likely to be enlarged from engorgement with bile. When the stone is impacted in the *common bile-duct*, the jaundice is intense, but the gall-bladder is usually small. The pain may be slight, but is often very severe. Generally the stone lodges close to the intestinal end of the duct in what is known as the ampulla of Vater, it may then ulcerate through into the bowel without much difficulty, but not unfrequently gives rise to an associated pancreatic inflammation. If impacted higher up, it may work through into the duodenum or colon by a process of ulceration, or may escape into the retro-peritoneal cellular tissue, leading to an abscess, or, again, it may open the peritoneal cavity, and thus cause acute peritonitis.

**Operative Treatment of Cholelithiasis** — The conditions which may call for operation in the course of a case of gallstones are as follows: (a) For recurrent attacks of biliary colic, which cannot be prevented by medical treatment, (b) for persistent jaundice, (c) when the gall-bladder can be felt enlarged and tender, and (d) for acute cholecystitis.

**Cholecystotomy** consists in opening the gall bladder for the removal of calculi, or for purposes of drainage. It is wise in all operations on the biliary passages to introduce a firm sandbag beneath the patient's back, as thereby much better access is given. The incision runs parallel to the costal margin on the right side, and about  $1\frac{1}{2}$  inches from it, extending upwards as far as the middle line (Fig 363, B), some authorities, however, recommend a vertical incision on the outer side or through the substance of the rectus. The peritoneum is opened and the gall-bladder sought for, any adhesions present being carefully divided, it will sometimes happen that these are so abundant as to prevent the surgeon from continuing the operation, the risk of opening the bowel by mistake being too great. The liver is drawn up, and the intestines are pressed downwards out of the field of operation by means of abdominal cloths held in position by a broad retractor. The general peritoneal cavity is thus carefully guarded from infection. If the gall bladder is much distended, it is advisable to tap it with a trocar and cannula, and withdraw the chief portion of its contents, the opening is then enlarged sufficiently to allow of the introduction of a scoop, or even of the finger, and by this means the calculi are removed. The bile-ducts are carefully examined both by the finger passed inside as far as possible, and outside along their whole length, and by means of a long probe passed down the duct. If the interior is tolerably healthy,

it may be advisable to suture up the wound in the bladder, the threads not being allowed, however, to encroach on the mucous membrane. A gauze wick should be inserted down to the incision before stitching up the abdominal parietes, so as to provide for drainage should there be any leakage of bile. This procedure is rarely advisable, as generally temporary drainage of the biliary passages does good by relieving the liver. A full-sized drainage-tube without any lateral openings is introduced into the gall-bladder and stitched to its walls, whilst the margins of the wound in the gall-bladder are united to the parietal peritoneum and transversalis aponeurosis. A biliary fistula is thus produced which discharges for a time, but when the obstruction to the onward passage of bile into the gut is overcome, the fistula usually closes. Occasionally this does not occur, and then the discharge of bile continues, necessitating further treatment. If there is sufficient evidence of the existence of bile in the motions to indicate that the passages are clear, a plastic operation for the closure of the fistula may be undertaken, but if complete and permanent obstruction to the passage of bile is suspected, an artificial communication with the intestine (cholecystenterostomy) should, if possible, be established.

When a stone is impacted in the cystic duct, it may be extracted by a lithotomy scoop, or pushed backwards by the finger and thumb from outside. Failing this, the duct may be incised and the stone removed, the incision being subsequently closed by sutures, but it is possible that a better line of practice would be to remove gall-bladder, cystic duct, and stone in one piece (cholecystectomy), if such be possible.

When the calculus is lodged in the common bile-duct behind the second piece of the duodenum, it is sometimes possible to push the gut aside after incising the peritoneum to the right of the descending portion, and get at the duct behind it, in other cases it may be necessary to incise the duodenum longitudinally front and back, and after extracting the stone, to make a fistula between the duct and the posterior wall of the intestine. An impacted stone should, if possible, never be left *in situ*, as although it may pass at the end of a few days or weeks, it will cause much pain, and before becoming dislodged it may do much harm, not only to the biliary apparatus, but also to the pancreas.

**Cholecystenterostomy**, or the formation of an artificial communication between the gall-bladder and the bowel, is required in cases where jaundice persists, owing to absolute stenosis of the common duct. It has also been undertaken for the relief of jaundice due to malignant disease, either of the head of the pancreas or of the intestine, causing pressure on the orifice of the bile-duct, it is quite unjustifiable under these latter circumstances, as statistics have shown that the danger of such a proceeding is very great. The parts are exposed as described above, the gall-bladder and duodenum are brought into contact and a lateral anastomosis made by simple suturing or by means of a Murphy button.

**Cholecystectomy**, or removal of the gall-bladder, may be necessary for traumatic lesions, and for malignant disease, whilst it is sometimes employed after cholecystotomy in order to prevent any new formation of gallstones. The bladder has to be isolated, and may then be cut away, the divided end of the duct being secured by a double row of sutures, or by a ligature as after removal of the appendix. As much of the peritoneal covering as possible must be saved in order to cover over the parts.

### Affections of the Pancreas

The pancreas is an organ which has only recently received much attention from surgeons, its depth and anatomical relations explain the neglect with which it was treated for so long. At the present time its affections are being studied by surgeons with a keen interest, and considerable operative activity is being directed towards it. There are two chief methods of approaching it. (1) The trans-peritoneal, in which the abdomen is opened in the middle line above the umbilicus, the gland is reached either above the stomach by dividing the small omentum, or by traversing the great omentum just below the great curvature of the stomach, or by opening through the transverse meso-colon. (2) The retro peritoneal method consists in an incision below the last rib in the lumbar region, but only the head or the tail is exposed by this procedure.

There are two chief risks associated with pancreatic lesions or operations. (1) The organ is very freely supplied with blood, and it is extremely difficult to ensure hæmostasis. Ligature of the pancreatic tissue causes necrosis, and from the necrotic tissue ferments are set free which act injuriously on the tissues around, and predispose to further hæmorrhage. Deep stitches and effective tamponade can alone be relied on in this direction. (2) The leakage of pancreatic juice is a serious danger to the patient in that it is likely to determine necrosis of fat wherever it spreads, hence foci of fat necrosis may be found scattered extensively through the omentum and mesentery in all acute pancreatic lesions. Moreover, it acts most prejudicially on the peritoneum, and induces either an aseptic peritonitis and intestinal paralysis which may prove fatal, or determines an infective peritonitis if bacteria are present.

**Wounds of the Pancreas** are due to direct violence applied to the epigastrium, and may result from penetrating or non-penetrating injuries. Necessarily, they are usually accompanied by lesions of other viscera, such as the stomach or duodenum, and it is important that surgeons should remember the necessity for examining this viscus in any traumatic condition in the neighbourhood. Deep sutures and tamponade must be used in all cases where solution of continuity has occurred, the latter being needed not only as a hæmostatic agent, but also in order to drain away any leakage of pancreatic fluid. Prolapse through an abdominal wound has been recorded in a few cases, the organ having been almost entirely

separated from its connections, however bruised or damaged, its total extirpation must never be resorted to, since diabetes is certain to follow, it should therefore be carefully purified and replaced

**Acute Pancreatitis** is a grave affection, frequently fatal, and not uncommonly mistaken for acute obstruction until diagnosed on the operating or post-mortem table. It may follow an injury, and is then due to an interstitial hæmorrhage, which gradually increases, a similar hæmorrhage sometimes appears spontaneously in alcoholic subjects, and is termed a 'pancreatic' apoplexy, it is quite possible for such cases to run an acute course and even prove fatal without infection. More usually the condition is infective, the bacteria reaching the gland from the intestine, or is determined by regurgitation of bile owing to the impaction of a biliary calculus in the ampulla of Vater. Pancreatic calculi also occur, and may light up an attack of acute pancreatitis, they are usually small and elongated, consisting mostly of carbonate of lime. The organ becomes enlarged, thickened, and congested, purulent foci are scattered here and there through it, and in and around it are found necrotic spots due to the action of the pancreatic secretion. Sometimes the whole gland or a large portion of it has been known to slough. In front occurs an inflammatory effusion, which is usually purulent and sometimes hæmorrhagic, it may be limited to the lesser sac of the peritoneum, then following the lines of a subphrenic abscess, or it may involve the general peritoneal cavity.

The **Symptoms** vary much, but usually start suddenly with acute epigastric pain, which soon becomes excruciating. This is accompanied by nausea and sickness, by constipation and abdominal distension, and by a serious collapse which may quickly prove fatal. The pain is due to the swollen organ pressing on the cœliac plexus of nerves. The swelling of the abdomen commences in the epigastrium, and may for a time be limited to that region, but subsequently the phenomena of acute diffuse peritonitis may supervene. Occasionally the trouble quiets down at the end of a few days, but much more frequently it is fatal. The **Diagnosis** usually made is that of acute obstruction, and the true nature of the case is only recognised on opening the abdomen. **Treatment** consists in laparotomy and giving an exit to the inflammatory exudate. If diffuse peritonitis is present, the abdomen must be well irrigated and drained, and the local phenomena laid bare, dead pancreatic tissue should be removed, and effective gauze drainage provided. If a localized abscess forms, the greatest care must be taken to guard against a generalized infection. Posterior drainage is advisable in all these cases.

**Chronic Pancreatitis** is not to be looked on as a very uncommon lesion. It is frequently associated with gallstones and inflammation of the biliary passages, and may follow gastro-duodenal catarrh or ulceration. The organ becomes harder than usual, or is shrunken and sclerosed. It may produce a swelling in the epigastrium which is likely to be mistaken for a pancreatic carcinoma, or the symptoms may be mainly of a dyspeptic type. Fixed epigastric pain is often

present, and a tender spot a little above the umbilicus. Diabetes may arise if the inflammation is parenchymatous, offensive diarrhœa with undigested fat in the stools and rapid wasting are also suggestive symptoms. Operative treatment may be of value, since pancreatic or biliary calculi may be found obstructing the duct, apart from this, benefit has certainly been derived by cholecystostomy and drainage of the biliary passages.

**Cysts of the Pancreas** have been observed and treated in so many cases since 1887 that their characters are pretty clearly known. Simple complete obstruction to the duct has been proved experimentally not to be a sufficient cause for the disease, some pathological condition of the epithelium must also be present, preventing the re-absorption of the retained secretion. Slight traumatism is a not uncommon cause, and a cyst may develop as a sequela of an attack of inflammation which has quieted down. The fluid within is usually turbid and brownish from admixture with blood, odourless, and with a fairly high specific gravity, it is of an alkaline or neutral reaction, and contains albumen, but no urea or bile, it is capable of peptonizing albumen, of emulsifying fat, and of converting starch into sugar. The cyst can be felt as a rounded, tense, fluctuating or elastic swelling, placed deeply in the abdomen, immoveable, and perhaps transmitting the aortic pulsation. The relations of a cyst to the stomach and transverse colon vary, the cyst primarily forms behind the stomach, but when it attains any size it projects anteriorly, and then most commonly approaches the abdominal wall below the stomach and above the transverse colon. More rarely it presents above the stomach, or below the transverse colon.

Pancreatic cysts usually develop in middle life, occurring most frequently in men, emaciation is sometimes marked, since a good proportion of the fatty food passes away in the motions, the skin is often dirty, earthy, and unhealthy-looking. Treatment consists in laying the cyst bare, the surgeon usually finding his way to it between the stomach and transverse colon. Its contents are then drawn off by trocar and cannula, and arrangements made for drainage. A large tube is inserted, either through the front, or from the back by the side of the vertebræ. The skin around usually becomes irritated by the discharge, owing to a process of digestion. The prognosis with such treatment is good, although healing may be slow, and a permanent fistula may develop. Korte collected 101 cases operated on, and of these 5 died, 4 from the direct result of the operation, 1 from infection of the fistula.

**Carcinoma of the Pancreas** is met with either as a primary growth, or secondary to a similar disease of the stomach or pylorus. It is usually, but not invariably, of a scirrhus type, and may lead to distension of the stomach from pressure on and constriction of the pylorus, and to jaundice and ascites by involving the bile-duct and portal vein. In one or two cases removal has been undertaken with success, although an exact diagnosis was not arrived at before the operation. Sarcomata and other tumours are very rare.



### Affections of the Spleen

**Rupture of the Spleen** occurs as a result of injury, causing great shock, pain in the left hypochondrium, and internal hæmorrhage, usually to such an extent as to prove rapidly fatal. In less severe cases the blood collects in the left loin, and gravitates towards the pelvis, the right loin being often kept clear by the position of the mesentery. Laparotomy should be undertaken wherever practicable, and, if much damaged, the organ is removed, the splenic vessels being secured by ligature, the results of such treatment have been most satisfactory. In a few cases it has been possible to stop the bleeding by inserting a gauze tampon, which is removed in a few days.

**Abscess of the Spleen** may develop in the course of pyæmia, or follow an injury, especially if associated with a lesion of a neighbouring coil of intestine. The symptoms are merely those of deep suppuration in the left hypochondrium, and the abscess either finds its way externally, or bursts into the peritoneal cavity. It may be opened and drained with the same precautions as for any other intra-peritoneal collection of matter, and the results hitherto obtained have been encouraging. In pyæmia the disease is often fatal before the local phenomena are recognised.

**Floating Spleen** is occasionally congenital, but more commonly acquired, in consequence of tight-lacing, injuries, or the presence of tumours. It is known by the existence of a moveable intra-abdominal swelling, whose shape is that of the spleen, and having a notch in its anterior border, its size increases after meals. It may be so displaced as to lie in the right iliac fossa, or even in the pelvis, and then has a long narrow pedicle which has, in a few cases, led to its torsion and strangulation. Splenectomy was formerly the only treatment, if the displaced organ caused discomfort or pain, it has been found possible, however, to fix it, and several successful cases have now been recorded. *Splenopexy*, as the operation is termed, is best undertaken by preparing a bed for the organ outside the peritoneum in the loose cellular tissue beneath the floating ribs on the left side. The spleen is then slipped through a small hole specially made for the purpose in the parietal peritoneum, and secured by stitches, which pass through its capsule and anchor it to the under surface of the diaphragm.

**Tumours of the Spleen** are met with either in the form of a general hypertrophy, as in lymphadenoma or malaria, or as new growths, such as cysts (hydatid most frequently), or secondary carcinoma or sarcoma. The spleen also becomes enlarged in lardaceous disease, rickets, and many of the general fevers. An enlarged spleen constitutes a swelling which extends downwards from the left hypochondrium towards the umbilicus, the notch perhaps being felt anteriorly. The condition is recognised by the constant absence of intestine in front of it, by the resonant note obtained in the flank, by its mobility with respiration, and occasionally by its increased size after meals.

The treatment, where advisable, consists either of splenectomy, or, in the case of cysts, of incision and drainage

*Splenectomy*, or extirpation of the spleen, has been undertaken for a variety of conditions, and its value and position as a surgical procedure are now pretty well established. For traumatic lesions it is both safe and justifiable. For primary hypertrophy, and for malarial enlargement, it may be performed if serious discomfort is being caused, and cannot otherwise be remedied. If drainage fails to cure cysts, excision may be performed. If malignant disease is diagnosed sufficiently early, the organ may be removed. Splenectomy for leucocythæmia is absolutely unjustifiable, all the cases operated on having died. The *operation* is performed through any suitable incision of sufficient length. The peritoneum having been opened, the organ is carefully examined, and if extensive adhesions are present, the surgeon will be wise to desist, since fatal hæmorrhage is very likely to result from any attempt to break them down. If the organ is freely moveable, it is carefully drawn out of the abdomen, the pedicle being isolated, and secured temporarily by pressure forceps. It is then cut away, and the pedicle tied after transfixion with silk ligatures, the ends of which are cut short and returned into the abdomen.

## CHAPTER XXXV

### HERNIA

By the term **Hernia** is meant the protrusion of some viscus from its normal situation through an opening in the walls of the cavity within which it is contained. This may affect not only the abdominal viscera, but also the brain and lungs, giving rise to conditions which we have already described. In this chapter we merely deal with hernia as met with in connection with the abdomen.

The most common **Situations** at which hernia occurs are those spots where the parietes are weakened by the transmission of such structures as the spermatic cord and round ligament (inguinal hernia), or at the entrance of the crural canal, where the main vessels of the leg pass under Poupart's ligament (femoral hernia), or at the umbilicus (umbilical hernia). Viscera may, however, protrude through the obturator foramen, sciatic notch, the diaphragm, and in various other situations.

**Ætiology** —A great many conditions may be associated, directly or indirectly, with the production of a hernia. They may, however, be described for practical purposes under two main headings—the congenital and the acquired.

**Congenital Causes** are rather predisposing than exciting in nature, and must be looked for amongst the many malformations and conditions of imperfect development to which the abdominal parietes and contents are liable. The following are the most important of these: (a) The non-obliteration of the funicular process of peritoneum, which in the male precedes and accompanies the testicle on its progress downwards from the abdominal cavity to the scrotum, and in the female passes along the round ligament. The so-called congenital inguinal hernia results from this, although it must be remembered that the rupture does not necessarily show itself at birth, and, indeed, may not appear till after puberty. In females under the age of twenty-five, hernia into the canal of Nuck, as this peritoneal tube is called, is the most frequent variety met with. (b) The late descent of the testis, whether it finds its way into the scrotum or not, is usually associated with the formation of an inguinal hernia of the congenital type, or of some form of interstitial hernia. (c) Inherited weakness of the abdominal muscles and parietes, with unusual patency

of the rings, will certainly predispose to this condition, and, moreover, there is no doubt as to the tendency of hernia to run in families (d) Abnormal length of the mesentery or omentum has also been looked on as a causative factor, but, although it may have some influence when other conditions are present, it can *per se* have but little effect (e) Congenital phimosis, by inducing forcible acts of micturition, acts as an exciting cause (f) Congenital apertures occur in the linea alba or linea semilunaris, especially opposite one of the muscular intersections in the rectus, and through these one form of ventral hernia may develop (g) The umbilicus is sometimes imperfectly developed at birth, permitting the viscera to protrude into the base of the umbilical cord (congenital umbilical hernia) (h) The diaphragm, is also occasionally defective, allowing the stomach or other viscera to find their way into the thoracic cavity

*Acquired Causes*—Hernia may result from any condition which tends either to weaken the abdominal parietes, or to increase the intra-abdominal pressure Thus, all violent exercise, especially when of an intermittent nature and accompanied by excessive straining, as in lifting heavy weights, may determine its occurrence, and the more so if the individual is forced to maintain the upright position, or wears tight bands or girths round the abdomen Pregnancy stretches the abdominal walls, and parturition, by inducing violent muscular contraction, may originate a rupture, either through a split in the linea alba or through the crural canal Prolonged and severe bronchitis also favours the occurrence of a hernia by the increase of intra-abdominal pressure due to coughing, whilst the straining to pass water in cases of enlarged prostate or stricture may act in a similar manner Chronic constipation is a frequent factor in its production, especially if the patient makes use of a closet with a high seat, whereby the inguinal canals are left unprotected, in uncivilized races, where defæcation is performed in the squatting posture, the lower part of the abdomen is supported by the flexed thighs, and hernia is very uncommon Patients with weak and bulging inguinal regions may with advantage use a low commode In old and weakly people, an additional cause may be found in the slipping downwards of the mesenteric attachment, causing the intestines to occupy the lower part of the abdomen rather than the upper, so that the former bulges out over the pelvic brim This is possibly due to weakening or relaxation of the unstriped muscular tissue which normally exists behind the peritoneum, passing from the posterior abdominal wall to the base of the mesentery, it is sometimes called the *muscle of Treitz* Obesity is also a predisposing factor to hernia, the accumulated fat being deposited in the omentum, mesentery, and subperitoneal tissue, thus increasing the intra-abdominal tension

**Structure**—A hernia consists of a sac and its contents, the sac being formed of peritoneum, perhaps thickened by additional coverings, derived from the abdominal parietes, and the contents being the protruded viscera

The sac, or peritoneal investment of an acquired hernia, is in the

early stages funnel-shaped, small, and thin, being derived from that portion of the serous membrane which normally lies over the hernial aperture. As the rupture increases in size, the sac becomes larger, partly as a result of the stretching of that portion of the serous membrane already protruded, and partly by the drawing down of fresh membrane from the neighbourhood, in the groin this is derived rather from the iliac fossa than from the anterior abdominal wall. The sac is described as consisting of two portions—the neck and the fundus. The *neck*, sometimes large and open at first, gradually becomes narrowed, and is generally thickened from the irritation to which it has been exposed, either from the wearing of a truss or from the pressure of the contained viscera. The body, or *fundus*, varies much in size and shape, and may undergo considerable alterations in structure.

(a) The sac, which is at first easily replaced, soon becomes *irreducible* from adhesions to surrounding parts, though it can still be readily emptied of its contents. (b) *Inflammation* may occur as a result of injury or pressure, constituting a form of localized peritonitis. If this is of a chronic type, the sac becomes thickened and opaque, with dilated vessels coursing over it, as seen especially in old irreducible herniæ. Acute or subacute inflammation is also met with, resulting in the formation of adhesions between the inner wall and the contained viscera, or between the opposite sides of the sac if no other structures interpose. Natural cure of a hernia may in this way be occasionally produced by adhesions forming across the neck of the sac, or by an adherent plug of omentum, thus occluding the communication with the peritoneal cavity. The lower portion of the sac may in a similar way be shut off from the upper, either by a band of adhesions or by a septum of adherent omentum, this isolated cavity is sometimes the seat of a serous effusion, known as a *hydrocele of a hernial sac*. (c) *Hæmorrhage* into the sac wall may result from violence, and will cause it to become much thickened, and even pigmented and leathery in appearance.

The *coverings* of the sac are indurated in old-standing cases, and matted together in such a manner as to render it impossible to recognise the constituent parts. This is specially noticeable at the neck of the sac, where their union with surrounding structures is often such as to constitute an important predisposing element in the production of strangulation. The opening through which the hernia protrudes loses its characteristic features and shape, being enlarged, more or less circular, and displaced so that an oblique passage, such as the inguinal canal, becomes straight, the internal abdominal ring lying almost immediately behind the external.

**Contents**—Any viscus in the abdomen may be found in the sac of a hernia, except, perhaps, the *pancreas*, as a rule, however, one finds only small intestine or omentum.

An *enterocele* is the name given to a hernia containing some portion of the bowel. It is at first reducible, but if the gut becomes adherent, either to the sac or to some other contained structure, it is rendered irreducible. It may also participate in an inflammatory condition of

the sac, whilst, if irreducible, obstruction may ensue from impaction of its contents, and if its vessels are constricted strangulation supervenes. For a description of these conditions, see p 1087. The small intestine is much more frequently involved than the large gut. The amount of bowel protruded varies from a few inches to several feet.

If omentum is found in a hernial sac, the condition is known as an *epiplocele*. As long as it remains reducible, it is likely to retain its normal texture, but when large in amount, and especially if irreducible, it becomes thickened, brawny, and matted together to such an extent as almost to constitute a solid tumour, it is often the seat of an excessive deposit of fat, and in consequence of this overgrowth it may become irreducible, even when no adhesions are present. Serous cysts sometimes develop within it as a result of effusion between opposed surfaces. In some cases openings are found in it of sufficient size to allow the gut to pass through and become strangulated. When omentum and bowel are present in the same sac, the condition is known as an *entero-epiplocele*.

The *Cæcum* sometimes occupies a hernial sac, either in aggravated and large herniæ, or in children with congenital hernia, it has even been found in a hernia on the left side. Since the cæcum has generally a complete serous covering and usually a mesentery, it is freely moveable, and may pass into a hernial sac in the same way as any other moveable part of the intestine. On the other hand, a few indisputable cases have been related in which the serous envelope was in a so-called 'cæcocele'.

*Appendix* is occasionally found in a hernial sac on the right side. It is rarely free, but generally fixed by adhesions and irreducible. The hernia is more painful than usual, and on palpation the appendix can sometimes be felt enlarged and tender, pressure causing pain referred to the umbilicus. The patient is likely to give a history of recurrent attacks of inflammation in the sac.

The *Bladder* may be associated with a hernial sac in two distinct ways, and usually in the inguinal region. (a) The fundus may be dragged downwards by the traction of the peritoneum, when the hernia has attained a colossal size. There is then only a partial peritoneal investment, the bladder lying outside the sac, and being adherent to it. Considerable irritability of the viscus is induced, and, owing to stagnation of urine in the displaced part, a phosphatic concretion may form therein, and such has even been removed by incision through the scrotum. (b) Occasionally a saccule of the outer wall of the bladder becomes adherent to the peritoneum, and is drawn down by it into the inguinal canal, its presence may be suspected if a small hernia is associated with much vesical irritability. Such a protrusion consists merely of thickened mucous membrane and submucous tissue, and is devoid of muscular fibres, it is very liable to be laid open if an operation for the radical cure is undertaken. If such an accident happens, the opening must be at once closed by sutures, which should not penetrate the mucous membrane, otherwise phosphatic concretions may form on the portion of suture exposed in the bladder, and cause subsequent trouble.

*Loose foreign bodies*, somewhat resembling marbles in size, are occasionally, but very rarely, met with in hernial sacs. They are derived from the detachment of one or more of the appendices epiploicæ, which subsequently become enlarged from a deposit of fibrin induced by movement in the peritoneal cavity, and may even calcify.

**Signs and Symptoms**—The characteristic features whereby a hernial protrusion is recognised consist in the presence of a rounded or pyriform swelling, in one of the normal or abnormal situations already mentioned, which increases in size when the patient stands, coughs, or strains, having, as it is termed, 'an impulse on coughing'. If intestine is present, it may be possible to obtain a tympanitic note on percussion, whilst the tumour is tense and rounded, and on pressure slips back into the abdomen with a distinct gurgle. An enterocele often gives rise to dyspeptic phenomena, and perhaps to colicky pains. An omental hernia feels soft and doughy, has a less distinct impulse, or even none, on coughing, and is replaced without a gurgle; it is dull on percussion. When allowed to reappear, it does so slowly without any sudden impulse, the omentum insinuating itself gently down the inguinal canal, and gradually distending the sac.

The **Treatment** of hernia, whether palliative by means of trusses, or radical by means of operation, differs so greatly in the various forms, that it will be better to discuss each one separately.

### Special Forms of Hernia

**Inguinal Hernia**—The term *inguinal hernia* is limited to those conditions in which a protrusion occurs into the inguinal canal, and if allowed to progress, finally makes its way through the external abdominal ring. If it extends into the scrotum, it is termed *complete*, or *scrotal*, whilst if it does not pass beyond the external abdominal ring, it is known as a *bubonocoele* or *incomplete inguinal hernia*. The neck is always in relation with the deep epigastric artery, and the structures of the cord are either spread out over the sac or are in close proximity to it. In the early stages, the pubic spine can be felt to the outer side of the neck of the sac, but as it increases in size it lies over the spine, which can only be felt after pushing the hernia upwards and inwards.

Two main varieties of inguinal hernia are described, viz., the oblique and the direct.

**An Oblique-Inguinal Hernia** (Fig 393) is one which passes down the whole length of the inguinal canal, entering at the internal and emerging at the external abdominal ring, the deep epigastric artery is thus placed to the inner side of the neck. During its passage through the canal every form of oblique hernia pushes before it and becomes covered by structures representing the various layers of the abdominal parietes. Hence, in cutting down on such a sac, the surgeon will divide, in addition to the skin and subcutaneous tissues, (a) the intercolumnar fascia, derived from the transverse fibres of the external oblique which pass across the external abdominal ring,

(b) the cremasteric muscle and fascia, representing and extending from the internal oblique, (c) the infundibuliform fascia derived from the fascia transversalis, and (d) finally, a layer of subserous tissue varying in thickness, and closely surrounding the peritoneal sac. In practice, the surgeon does not attempt to recognise these different coverings, the only one of importance being the cremasteric, the muscular fibres of which are often evident, and serve as a useful landmark.

There are three different forms of oblique inguinal hernia, viz., the acquired, the congenital, and the infantile or encysted.

1. An *Acquired Inguinal Hernia* (Fig. 394) is one in which the sac consists entirely of peritoneum protruded from within the abdomen. It gradually increases in size, and finds its way along the cord to the

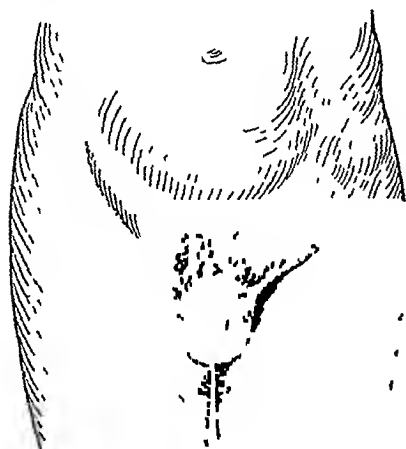


FIG 393—DOUBLE OBLIQUE INGUINAL HERNIA

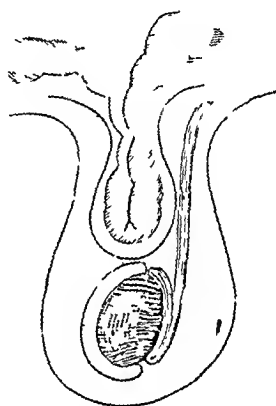


FIG 394—DIAGRAM OF ACQUIRED INGUINAL HERNIA, SHOWING SEROUS SAC WITH INTESTINE COMING DOWN TO THE TOP OF THE TESTIS

scrotum. The sac usually extends as far as the head of the epididymis, but if of a large size it may overlap the testicle, which lies behind it. The structures of the cord are frequently spread out over the sac. In old standing cases the internal ring is dragged downwards and inwards, and often lies behind the outer, and thus it may be difficult, apart from operation, to determine whether any particular hernia is direct or oblique. In many early cases the sac is so distinctly flask shaped as to suggest that the condition was really due to the non-closure of the uppermost part of the funicular process.

2. *Congenital Inguinal Hernia* (Fig. 395) is due to non-closure of the funicular process of peritoneum, which passes down to the scrotum with the testicle, and is usually obliterated completely except below, where it forms the tunica vaginalis. As already mentioned, the hernia does not necessarily appear in infancy, its occurrence being often delayed until puberty, or when the patient has to undertake heavy work. This form of hernia is much more frequently met with



on the right-side of the body, owing to the fact that the right testicle descends into the scrotum at a later date than the left. It is always characterized by becoming complete at once, and its development may be immediately followed by acute strangulation.

When the non-obliteration is complete and the patent funicular

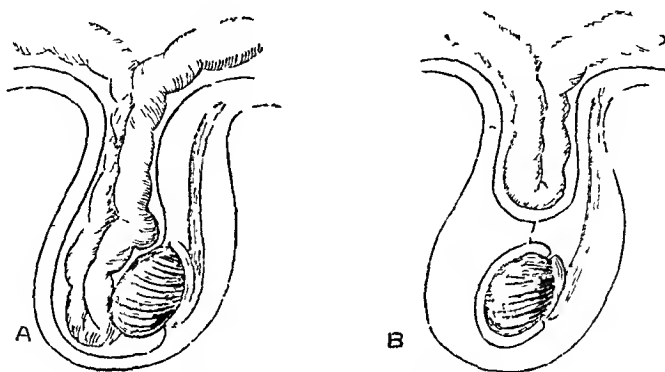


FIG 395 —CONGENITAL INGUINAL HERNIA

A, Vaginal variety, B, funicular type

process is continuous with the tunica vaginalis, the protruded viscera lie in contact with the testis, and somewhat obscure it, this is known as a *congenital vaginal hernia* (Fig 395, A). Less frequently the funicular process is patent only as far as the head of the epididymis, being shut off from the tunica vaginalis. The hernia under such

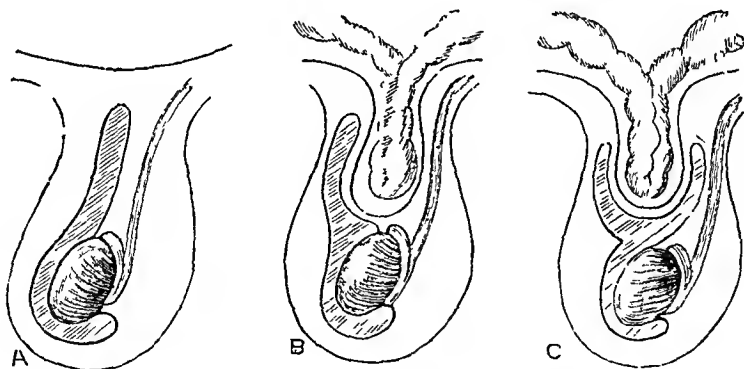


FIG 396 —INFANTILE INGUINAL HERNIA

A Prehermial condition with tunica vaginalis extending upwards to inguinal canal. B hernial sac coming down behind tunica, C, sac invaginating the tunica vaginalis.

circumstances exactly resembles the acquired variety, being unrecognisable from it except by the fact that it becomes complete at once. It is termed a *congenital funicular hernia* (Fig 395, B).

In every case of congenital hernia the structures of the cord are spread out over the sac, and more intimately adherent to it than in

## HERNIA

the acquired form Phimosis is usually associated with this condition in young boys

3 The *Infantile* or *Encysted Hernia* is one occurring in individuals in whom the funicular process, although shut off from the abdominal cavity above, remains patent below, communicating with the tunica vaginalis, which cavity extends, in consequence, as high as the inguinal canal (Fig 396, A) The hernia has a distinct sac, which passes down behind the open process, or invaginates it (Fig. 396, B and C) It cannot be recognised except on operation, when the surgeon is apt to open the tunica vaginalis, which, though reaching upwards, does not communicate with the general peritoneal cavity, on removing or displacing this, the true sac of the hernia is found behind it This is not so likely to occur at the present day, when the high incision is made

A Direct Inguinal Hernia (Fig 397) is one which, though passing through the external abdominal ring, has only travelled through a portion of the inguinal canal, it is never congenital, and usually smaller than the oblique type The neck lies to the inner side of the epigastric artery, which is often arched very distinctly over it, passing also along its upper wall known as Hesselbach's triangle, which is bounded internally by the outer border of the rectus muscle, by the deep epigastric artery externally, and by Poupart's ligament below (Fig 398) The obliterated hypogastric artery passes across this space in a direction parallel to its outer border, dividing it into two parts, and according to whether the hernia protrudes through the inner or outer segment, it is known as an internal or external direct hernia (Fig 398, 3 and 2) The spermatic cord usually lies to the outer side of a direct hernia, and its constituent elements are never spread out over the sac as in the oblique form A direct hernia is rarely found in young people, and there is often a considerable amount of subperitoneal tissue covering the sac

The *External Direct Hernia* is very similar in nature to the acquired oblique form, except that it is placed to the inner side of the deep epigastric artery, and pushes in front of it the transversalis, instead of the infundibuliform, fascia It lies to the outer side of the conjoint tendon, and has a less complete covering of the cremaster muscle

The *Internal Direct Hernia* issues from the abdomen to the inner side of the obliterated hypogastric artery, rupturing or pushing before it the conjoint tendon, which in such a case is poorly developed

The coverings are the same as for the external variety

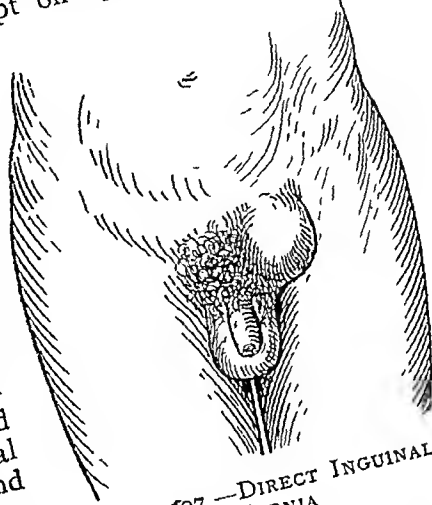


FIG 397 —DIRECT INGUINAL  
HERNIA

Interstitial Hernia is the name given to an inguinal hernia which does not follow its usual course, but develops in some abnormal relation to the abdominal wall. Three varieties are described (a) Where a sac exists between the transversalis fascia and the peritoneum (intra-parietal form, or pro-peritoneal hernia), either with or without a hernia in the usual position, in the former instance one form of 'hernia en bissac' is produced. This abnormal pocket of the sac is found either between the symphysis pubis and the bladder (hernia inguinalis antevsicalis), or it extends outwards towards the iliac fossa (hernia inguinalis intra-iliaca). As no external swelling is caused by this condition, it is usually impossible to recognise its existence prior to

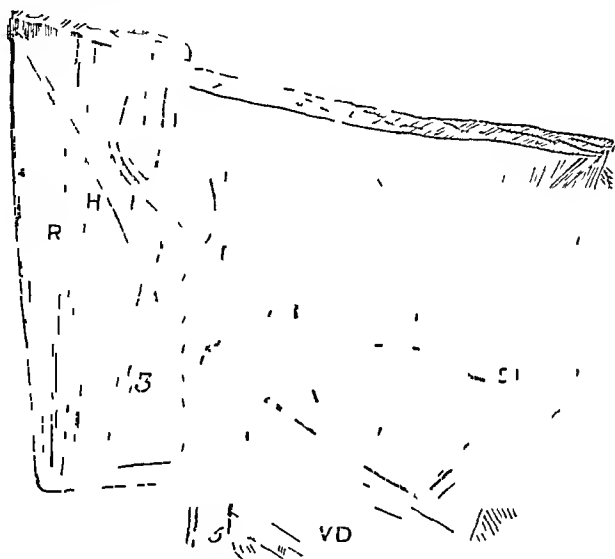


FIG 398 —ABDOMINAL WALL FROM WITHIN, TO SHOW HERNIAL APERTURES

A, V, Femoral artery and vein SV spermatic vessels PL Poupart's ligament VD, vas deferens, E, epigastric vessels R, rectus abdominis, H obliterated hypogastric artery 1, internal abdominal ring 2 and 3, sites of external and internal direct hernia in Hesselbach's triangle, 4, crural ring for femoral hernia, 5, obturator foramen and vessels

operation, occasionally it is the cause of a continuation of the symptoms of strangulation, when apparently successful taxis has been performed, owing to the strangled bowel being pushed backwards from the superficial into the deeper portion of the sac (b) An abnormal expansion or bulging of the sac is situated between the internal and external oblique muscles (inter-parietal form). A swelling is thus produced in the region of the inguinal canal, covered by the external oblique aponeurosis, and tending to spread upwards and outwards parallel with Poupart's ligament. The sac is often shaped like an hour-glass, a more or less complete septum existing at the level of the external abdominal ring, formed either by adhesions or by a mass of adherent omentum. The usual downward course of the hernial contents is thus prevented, and the sac yields laterally above the site of

the obstruction, and passes between the muscles (c) The hernia escapes as usual from the external abdominal ring, but travels outward along Poupart's ligament, somewhat simulating a femoral hernia (*extra-parietal* variety) This form is generally associated with late descent of the testis, and a contracted state of the scrotum, so that it is easier for the hernia, which is always of a congenital type, to pass into the thigh, and be guided by the fascia in the direction indicated, in a case of this character operated upon a few years back, the testicle was found lying close to the anterior superior iliac spine There is no difficulty in recognising such a condition

The Signs of an inguinal hernia do not require much special notice here, as we have already described the general clinical features of a rupture (p 1066) In the early stages, where merely a bubonocoele exists, a fulness is noted in the course of the inguinal canal, which increases when the patient coughs, it is best detected by a finger passed through the external ring into the canal When it descends into the scrotum, the swelling increases in size from above downwards, and in the oblique variety is continuous with the fulness in the inguinal canal The structures of the cord are masked by the presence of the hernia, but the testicle is to be more or less distinctly felt at the lower and back part of the swelling When of the direct variety, the cord lies to the outer side, and although the hernia can be felt projecting from the external ring, it passes directly backwards, and there is no fulness along the course of the canal

Inguinal hernia is usually met with in the male sex, the oblique variety being more common in the young, and the direct in elderly patients In the female sex it is rare, except in girls and young nulliparous women, in such cases it is almost always congenital, passing into the labium along the canal of Nuck, but rarely attaining any considerable size

The Diagnosis of an inguinal hernia is a tolerably simple matter if it is uncomplicated by any other condition, it may, however, be difficult, and in old-standing cases it is often impossible to distinguish the oblique variety from the direct The conditions for which it may be mistaken are best considered in two groups

1 Whilst the hernia is still incomplete and in the bubonocoele stage, it has to be distinguished from the following (a) *Encysted hydrocele* of the cord, which is recognised by its smooth globular outline and tense walls, the impulse on coughing is less distinct, and, although freely moveable in the canal, the hydrocele cannot always be entirely reduced into the abdomen, whilst the characteristic gurgle of a hernia is absent, traction on the testis, moreover, fixes the tumour, and renders it immobile The exact limitation of the upper end of the swelling, if it can be reached, is very characteristic of a hydrocele (b) A *chronic abscess* originating in the abdominal parietes, or within the abdomen or pelvis, will sometimes point through the external abdominal ring In such cases, although there is a distinct impulse on coughing, and although the swelling is reducible, it has not the definite outline and characteristic sensation of a hernia,

being usually soft and fluctuant. Other evidences pointing to the existence of the original disease may also assist in determining the nature of the swelling. (c) *Enlarged glands in the groin* which have become adherent to the external oblique are sometimes mistaken for a hernia, owing to the fact that on coughing a distinct impulse is communicated to them, it is, however, merely heaving in nature, and not expansile, whilst on digital exploration of the inguinal canal the absence of a hernia may be readily ascertained. (d) A *testicle retained in the inguinal canal* is recognised by that side of the scrotum being empty, and on pressing the swelling testicular sensation may be elicited. The rounded upper end of the testis can often be detected. (e) *Tumours consisting of fat or other tissues* are occasionally seen in the inguinal canal, but are characterized by the strict limitation of their upper border and usually by the absence of a distinct impulse on coughing. On the other hand, as described elsewhere, a mass of fat simulating a lipoma is sometimes present, resulting from a protrusion of the subperitoneal tissue, a hernial sac being found embedded in its interior. (f) *Hæmatocoe of the cord* is recognised by a history of injury, the presence of pain and ecchymosis, and the absence of an impulse on coughing, whilst reduction is impracticable.

2 *When the hernia extends into the scrotum*, less difficulty is experienced in its diagnosis. By examination of the cord immediately outside the external abdominal ring, all purely scrotal swellings, such as hydrocele or sarcocele, are readily eliminated, since in them the cord can, in the early stages, be felt perfectly free. A varicocele can also be similarly recognised from an omental hernia by the condition of the cord in its upper region, moreover, if the patient is made to assume the recumbent posture, the swelling disappears in each instance, but if a finger is placed firmly over the inguinal canal so as to prevent any protrusion of omentum, and he is then directed to stand up, the swelling immediately reappears if it is venous in character. To the practised finger, the diagnosis is never a matter of difficulty, since the enlarged veins of a varicocele and omentum are not at all alike to the touch, the veins moving freely under the finger 'like worms in a bag'. When a hernia is associated with a hydrocele or sarcocele, a little more care is necessary in order to distinguish between the two swellings.

The **Treatment** of inguinal hernia is either palliative by means of trusses, or radical.

**Palliative Treatment** — Many different *trusses* have been introduced in order to prevent the descent of a hernia. No one form is capable of dealing with every case, and hence the truss must be selected with care, so as to suit the special needs of the particular patient. It is impossible to describe a title of the varieties which have been suggested, and hence we must refer our readers to special works on the subject. Suffice it to indicate the essentials of a good truss. It should consist of a pad kept in position over the hernial aperture by a steel spring (Fig. 399), it must fit the patient accurately, resting behind on the middle piece of the sacrum, and passing laterally mid-

way between the crest of the ilium and the top of the great trochanter. If the hernia is unilateral, the spring ends on the sound side just behind the anterior superior spine, and is prolonged anteriorly into a leather thong or cross-strap, which is secured to a stud on the pad. To prevent it from slipping up, an under-strap passes from the affected side close behind the anterior superior spine along the fold of the nates to the inner side of the thigh, being fixed finally to a second stud on the pad. The pad may be rounded or oval in shape, and usually consists of soft iron protected by cork, but polished vulcanite, wood, or an indiarubber cushion filled with air, water, or glycerine have been employed instead, it should be well covered with leather, and the strength of the spring must be so adjusted as

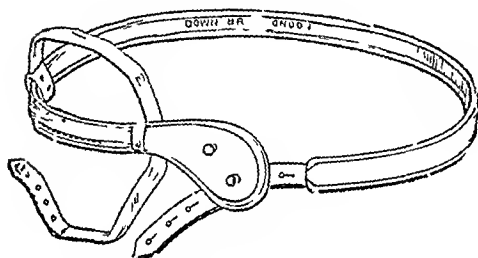


FIG 399—INGUINAL TRUSS (DOWN BROTHERS)

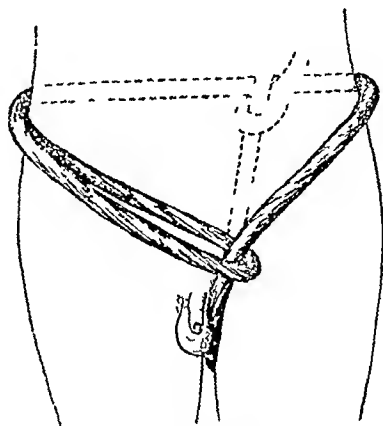


FIG 400—WOOL TRUSS FOR TREATMENT OF HERNIA IN CHILDREN

to retain the hernia under all conditions of strain to which it may be subjected, but without the use of undue force. In ordering a truss from an instrument-maker, the only measurement required is that around the body, following the line taken by the truss, and reaching in front to the symphysis pubis, it is also advisable to mention the size of the hernia, and whether the opening in the abdominal parietes is large or small. In the earlier cases of oblique hernia, the pad should rest rather over the inguinal canal than over the external abdominal ring, the object being to restore the valve-like action of the canal by approximating its sides. In a direct hernia the pad must be applied directly over the opening. If such an apparatus is properly adjusted and continuously worn, a cure is sometimes established in the course of a year or two, and in cases of congenital hernia in children a cure may be confidently expected if the mother or attendants of the child conscientiously carry out the necessary details. If the hernia is once allowed to slip down, even after six or twelve months' treatment, all the previous good will have been undone.

In infants, an efficient support is afforded by a skein of wool (specially known as 'fingering'), divided at one end, so that when

placed round the body the cut ends of the skein can be passed through the loop, forming a knot over the inguinal canal, which acts as the pad of a truss. The cut ends are now passed under the perineum, and tied to the transverse portion behind (Fig 400). This apparatus is changed night and morning when the child is bathed, and also, if need be, at shorter intervals, the mother being previously instructed as to how to support the hernia whilst the apparatus is being removed. In cases of double rupture in infants an indiarubber band with two pneumatic air-pads (Fig 401), arranged so as to fit over the inguinal canals, and with suitable straps and studs, will often suffice, and is certainly more comfortable than a spring truss. In addition to such pressure, it is important to remove all causes of intra-abdominal tension, as by circumcision, where phimosis is present, or by regulating the bowels.

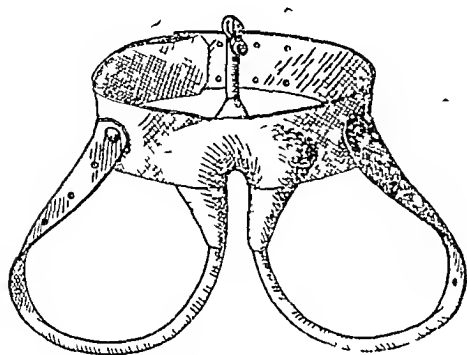


FIG 401 —INDIARUBBER BAND TRUSS, WITH AIR-PADS, FOR INFANTS

The air-pads fit around the root of the penis, and are inflated through the tube tied up in front. The under- straps fit round the child's thighs

The Radical Cure of inguinal hernia is an operation to which much attention has been directed of late years, since its value was brought prominently before the profession by the late Professor John Wood and others. It is very largely employed at the present day, and may be expected to give excellent results

if the cases are carefully selected, if the technique is satisfactory, and if the after-treatment is efficient. The mortality is very small, and in a series of 7,419 cases collected by Sultan, it did not exceed 0.48 per cent \*

The selection of cases for an operation of this type, which is not an essential, but only a desirable means of treatment (or, as it is sometimes termed, an *opération de complaisance*), is a matter requiring considerable judgment and discrimination. In an individual whose occupation does not subject him to heavy strain or exertion, and who possesses a hernia which, under ordinary circumstances, is easily commanded by a suitably applied truss, no operation is absolutely necessary, although one is perfectly justified in urging him to submit to it, since he will be thereby freed from the irksomeness of wearing a truss, and from the possible occurrence of strangulation. If, however, the subject is a labouring man, exposed to injury and strain, and who may find it difficult to provide a suitable series of trusses, the operation should always be undertaken unless distinctly contra-indicated (1) by a general inherited weakness of the abdominal muscles, (2) by a relaxed and atonic condition of the abdominal

\* *Munch Med Wochens*, February 3, 1903

parietes, which is so commonly associated in elderly people with slipping downwards of the mesenteric attachment of the intestine (enteroptosis), so that the hypogastrium obviously bulges, or (3) by such constitutional disease as precludes all unnecessary operative interference (4) Again, in cases of extensive irreducible hernia, the return of large masses of intestine which have lain for years in the hernial sac so increases the intra-abdominal tension as frequently to determine recurrence locally or elsewhere, and therefore operative interference, though very desirable owing to the great risk of strangulation incurred by the patient, is often followed by very bad results, unless the patient has previously been put through a course of semi-starvation and persistent taxis in order to reduce gradually the size of the protrusion.

As to the best age at which to operate, statistics definitely prove that it is essentially an operation of adolescence, the results gradually getting worse as the age increases. Young children should not be touched until careful truss pressure for a year has failed, or unless it is impossible to keep up the hernia by such treatment. In any case it is perhaps wiser to delay it until the age of three, owing to the risk of infection of the wound from the constant saturation of the dressings with urine.

Very many different operations have been described and practised by various surgeons. One of the most satisfactory is that known as *Bassini's*, which has now been extensively employed, and has been followed by a large measure of success. The instruments required are scalpels, forcipressure forceps, dissecting forceps, retractors, transfixion needle, curved hernia needles, and scissors. The operation may be described in the following stages. (1) The pubic region having been previously shaved and thoroughly purified, an incision is made in the direction of the inguinal canal and cord, about  $2\frac{1}{2}$  inches in length, its centre being a little above the external abdominal ring. This is carried through the skin and subcutaneous tissues until the structures of the cord are reached, the superficial external pudic artery being necessarily divided *en route*, the pillars of the ring are clearly defined, and the external oblique aponeurosis slit up for about  $\frac{1}{4}$  inch beyond the apex of the ring in the direction of the cord. (2) The sac has now to be identified, if the hernia is one of old standing, or contains adherent omentum or intestine, it is easily recognised, but if it is thin, empty, and of recent formation, and especially in the case of a bubonocoele, its identification may be a matter of some difficulty. The structures of the cord are lifted up out of the wound, spread out over the fingers, the coverings divided, and the white convex border of the fundus of the sac looked for. It is occasionally necessary to induce vomiting by titillation of the fauces, in order to cause the hernia to protrude, particularly when it is of the direct type. (3) If the sac is empty, it is freed from its connection with the structures of the cord without opening it, and isolated as far as or beyond the internal abdominal ring, as indicated by a collar of fatty subperitoneal tissue surrounding the neck. If



the hernia is irreducible, the sac is laid open, its contents freed from adhesions, and the intestine returned into the abdomen, whilst omental tissue is removed, and the stump replaced. The greatest gentleness must be employed in dealing with the intestines, if a considerable amount is present, it must be surrounded by a cloth wrung out of warm sterilized salt solution. Adhesions are carefully divided either by the finger or between ligatures, if closely adherent to the sac, it may be necessary to leave a small portion of this attached to the gut, which is then returned. Omentum, whether adherent or not, should be removed, as the elongated fringes are.

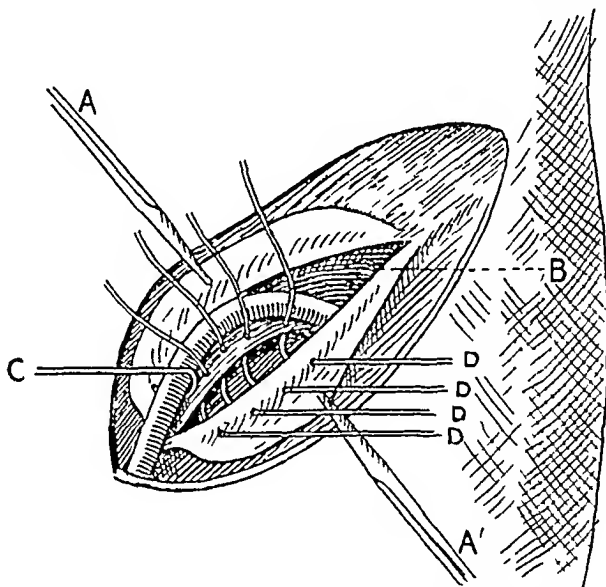


FIG 402 —BASSINI'S OPERATION FOR RADICAL CURE OF HERNIA

A and A', Spencer Wells forceps, holding aside the divided portions of external oblique aponeurosis, B, arched fibres of internal oblique, continuous on the inner side with the conjoint tendon, C, hook or retractor holding aside the spermatic cord, D D,D,D, deep silk stitches passed behind the cord through the deepest fibres of Poupart's ligament on the outer side, and conjoined tendon on the inner (The cutaneous incision and the incision through the external oblique are here shown much greater than would actually be undertaken, in order to demonstrate clearly the deeper parts)

very liable to contract adhesions to the abdominal parietes, which subsequently produce mischief. In removing omentum, it is not advisable to encircle a large mass with a single ligature, as the vessels are less securely commanded, and a pocket or pucker may be produced, possibly leading to internal strangulation at a later date. Small portions, including one or more of the larger vessels, should be taken up one after another, and tied separately and with advantage at different levels, so as to assist in the subsequent return of the stump. The protruded mass is then cut away below the ligatures, and the stump replaced after seeing that no bleeding point remains unsecured. The sac, being now emptied, is isolated as far as the

internal ring (4) The neck is then transfixed as high as possible, and ligatured with sterilized silk, and the sac cut off below the ligature, the stump retracting well above the internal ring, and presenting a flush surface towards the intestines, as we have been able to demonstrate in a post-mortem specimen, obtained from a patient who died of pulmonary embolus ten days after operation (5) The tissues of the cord are carefully examined, and any varicose spermatic veins removed, as also any downgrowths of the subperitoneal fat and possibly portions of the cremaster (6) The opening in the abdominal parietes is closed by a row of sutures passing through the arched fibres of the internal oblique and transversalis muscles, or through the conjoined tendon on the inner side, and through Poupart's ligament on the outer, the stitches being all placed behind the cord To effect this, the cord is drawn up out of the wound and held aside by a retractor (Fig 402, C), whilst the divided margins of the external oblique aponeurosis are grasped by pressure forceps (A, A<sup>1</sup>) Gentle traction on the lower pair enables the deepest portion of Poupart's ligament to be defined and seen The stitches must secure a good hold of the tissues, but should not include the external oblique aponeurosis, and when dealing with Poupart's ligament the proximity of the iliac vessels must not be forgotten Either interrupted or looped mattress sutures may be used, but if the latter, they must not be tied too tightly, as they may strangle the portions of tissue included in their grasp and cause necrosis The opening in the abdominal parietes is in this way commanded as far down as the pubic spine, but sufficient room must be left at the upper end for the passage of the cord, undue constriction of which would cause atrophy of the testis, sometimes it is desirable to introduce a stitch above the cord, in order to command a spot where recurrence is not uncommon When the three or four needful stitches have been introduced and tightened, the cord is replaced, and the divided portions of the external oblique are sutured together over it (7) The wound in the skin is closed by a continuous suture, and usually no drainage-tube is needed

**After-Treatment** —The patient is placed in bed with the head low, and the knees slightly flexed over a pillow The wound, as a rule, does not require dressing for seven or eight days, when, on removal of the stitches, it should be found completely healed, if asepsis has been maintained The patient should turn to the opposite side in order to pass water, and the greatest care must be taken to prevent the dressing becoming soiled Occasionally retention of urine follows this operation, necessitating the use of a catheter In the case of children, it is well to seal the parts down after the first twenty-four hours by a collodion dressing, and by preference the collodion should be of the flexible type, but with the guncotton replaced by celloidin (*celloidin collodion*)

The recumbent posture should be maintained for three weeks, and nothing but the slightest work undertaken for at least six weeks, and no violent effort until six months after the operation Under such circumstances the use of a truss is unnecessary, and, indeed, we

consider that it is undesirable, as its pressure is liable to produce atrophy of the newly-formed cicatricial tissue. When, however, the abdominal walls are congenitally weak, or if, unfortunately, the wound has suppurated, the deep stitches coming away, it is advisable to use a light truss for a time.

The treatment of *congenital hernia* differs in no particular from that already described, except that the sac must be divided below as well as above, and the lower opening secured by suture or ligature, so as to close the cavity of the tunica vaginalis. The operation often proves difficult owing to the intimate adhesions between the sac and the structures of the cord, and it is sometimes impracticable to isolate completely the neck of the sac. In many cases the old-fashioned Mitchell Banks' operation suffices for a congenital hernia.

The other operations which require to be mentioned are as follows.

(a) In *Banks' Operation*, the sac is isolated and removed as high as the internal ring without any division of the external oblique. Stitches are then introduced through the conjoined tendon and Poupart's ligament respectively, including the external oblique in their grasp, and passing *in front of* the cord. It is obvious that by such a plan the deep ring cannot be closed as accurately as in Bassini's operation. It may suffice, however, in a few of the simpler congenital cases.

(b) *Ball's Operation* consists in freeing the peritoneum on the inner aspect of the internal abdominal ring, and then the sac, after being isolated, is twisted into a tense cord, so as to throw it into a series of folds, thereby producing a prominence internally rather than an infundibuliform depression. To prevent untwisting, a ligature is tied around it as high as possible, and it is also transfixed below the ligature by a thread, the ends of which are passed through the abdominal parietes.

(c) In what is known as *Barker's Operation* the neck of the sac is isolated, ligatured, and divided, the fundus being left *in situ*, whilst the thread used in tying the neck is employed as the first suture to close the deep part of the canal, by this means it is hoped that the neck of the sack will be displaced, and hence more satisfactorily occluded. It is very doubtful, however, whether this really occurs.

(d) In *Macewen's Method* the aponeurosis of the external oblique is most carefully maintained intact, and the inguinal canal is explored through the external abdominal ring. The sac is freed from its surroundings, and this liberation goes on for about an inch all round the internal abdominal ring. A silk suture is then tied to the fundus of the sac, and is carried by a curved needle through the centre of the sac from above downwards and again through the neck of the sac from below upwards. The needle is then introduced through the inguinal canal under the loosened abdominal parietes, and is made to emerge through the abdominal muscles a little above the inguinal canal, the silk thread is carried through this, and by a little traction the sac is carried in, doubled up, and implanted as a pad across the internal ring. This thread is held by an assistant during the next

step of the operation This consists in closing the canal by one or more looped sutures, passed in such a way as to draw up Poupart's ligament over the arched fibres of the internal oblique in front of the cord Finally, the thread used for the fixation of the sac is drawn tight, and its free end employed to close the external abdominal ring to a sufficient extent The results of this proceeding are very good, but it is a more difficult operation than Bassini's, and one loses the advantage of opening the canal, and thereby exploring the structures of the cord One is frequently finding subperitoneal lipomata in the canal, and these would inevitably be left, and would possibly lead to a recurrence of the hernia, if the canal had not been opened up

(e) *Halsted's Operation* is much the same as Bassini's, except that the fibres of the internal oblique are also divided at the outer margin of the internal ring, and the cord displaced upwards and outwards through this opening, so that at the spot at which it pierces the abdominal parietes it may be surrounded by muscular fibres The canal is then closed as in Bassini's operation, whilst the external oblique is also sutured behind the cord, which is thus made a subcutaneous structure We see no special advantage to be gained by this departure from Nature's method of conducting the cord and its structures through the abdominal wall in an oblique direction

**Recurrence after Operation** is much less common than formerly, and statistics go to prove that in experienced hands not more than 10 per cent of the cases recur, and that rarely after the first twelve months As already stated, it may be due partly to an injudicious selection of cases, partly to errors of technique, and in part to a faulty after-treatment, the patient being given too much liberty at too early a date In connection with this we would especially emphasize the necessity for isolating the sac as far as possible, since otherwise the infundibuliform opening at the top of the closed peritoneal canal is certain to persist Another, and that perhaps the most common, cause of recurrence is septic contamination of the wound, if the deep stitches are not involved, no great harm is done, but whenever they have been removed or come away it is wise to use a truss subsequently as a precautionary measure Again, the mere restoration of a mass of intestine or omentum into the abdominal cavity may suffice to raise the intra-abdominal pressure, and thus predispose to a recurrence, hence the importance of removing as much omental tissue as possible in all bad cases Relapses may also be due to splitting or tearing of the tendinous structures around, either by the mere passage of the needle, or by the traction induced by tightening the sutures, indeed, it is often the case that a hernia originally oblique may after operation be followed by one that is direct, and probably from this cause

Whenever it appears likely that recurrence may occur, a truss should be ordered If, however, a hernia has developed, a second operation should be performed, if the condition of the abdominal parietes warrants it

**Femoral Hernia** —A femoral hernia is one which, travelling down the crural canal, presents at the inner and upper part of the thigh through the saphenous opening. It occurs most commonly in women, on account of the greater expansion of the iliac crests allowing increased space beneath Poupart's ligament, and especially in those who have borne children. During parturition the inguinal regions are in a measure protected, and hence inguinal hernia is rarely caused in this way. The crural canal constitutes the inner compartment of the femoral sheath, a space usually occupied by fatty cellular tissue, lymphatic vessels, and perhaps a lymphatic gland. It is about  $\frac{1}{3}$  inch in length anteriorly, and  $1\frac{1}{2}$  inches along its posterior wall, it is closed above by a thickened portion of the subserous cellular tissue known as the septum crurale, and its lower end is formed by the saphenous opening, and closed by the cribriform fascia. Hence a femoral hernia, as it passes downwards, receives the following coverings (*a*) peritoneum, (*b*) subserous cellular tissue, including the septum crurale, a layer sometimes known as the fascia propria, and occasionally represented by a thick fatty envelope, (*c*) the anterior layer of the femoral sheath, derived from the fascia transversalis, (*d*) cribriform fascia, (*e*) subcutaneous tissue, and (*f*) skin. In its passage through the canal it is situated immediately internal to the femoral vein, and pressure upon this may produce œdema of the leg, whilst Gimbernat's ligament lies to the inner side. The spermatic cord or round ligament is placed just above and internal to it, but on a superficial plane, whilst the epigastric artery is not very far from the outer side of the neck. Occasionally the obturator artery arises from this latter vessel (once in three and a half subjects), it may pass to the inner side of the neck of the sac along the border of Gimbernat's ligament (once in seventy-five times), but more commonly runs between the neck and the femoral vein. When once it has emerged from the saphenous opening, a femoral hernia usually travels upwards and outwards along Poupart's ligament towards the anterior superior iliac spine, being guided by the attachment of the deep layer of the superficial fascia, when of large size, it may extend considerably above the level of Poupart's ligament. Femoral herniæ are less likely to contain omentum than the inguinal variety, a portion of the ileum is most often present, but occasionally the ovary or Fallopian tube may be found in the sac.

The **Signs** of a femoral hernia are very characteristic. A swelling with an impulse on coughing, and more or less reducible, forms on the inner side of the thigh, its neck or aperture of communication with the abdomen lying to the inner side of the femoral vessels, and to the outer side of the pubic spine, which can always be felt (Fig 403). There is usually but little difficulty in making a **diagnosis**, although occasionally considerable care is needed, and especially in distinguishing it from the following conditions (*a*) From inguinal hernia, which is more common in young males, its neck occupying the inguinal canal, and the saphenous opening being free, whilst it is also above and internal to the pubic spine, and above Poupart's ligament at its

point of exit, it tends to pass downwards into the scrotum, or in females into the labium. Femoral hernia, on the other hand, usually (but not invariably) occurs in women over twenty-five years of age, the inguinal canal is free, whilst the neck is in the situation of the crural canal, below and external to the pubic spine, and below Poupart's ligament, moreover, it travels upwards and outwards, the labium being unaffected. (b) An *enlarged lymphatic gland* over the saphenous opening may simulate this condition very closely, but the absence of impulse on coughing and of the usual hernial signs is generally sufficient to distinguish it, when, however, the hernia is purely omental and irreducible, the impulse is so slightly marked that correct diagnosis in a stout woman is often difficult without an exploratory incision. (c) A small *lipoma* in the canal somewhat resembles a hernia, but the limitation of the tumour, its greater mobility, and the absence of an impulse on coughing, should suffice to prevent a mistake. (d) A *psoas abscess* pointing at the saphenous opening resembles a hernia in the existence

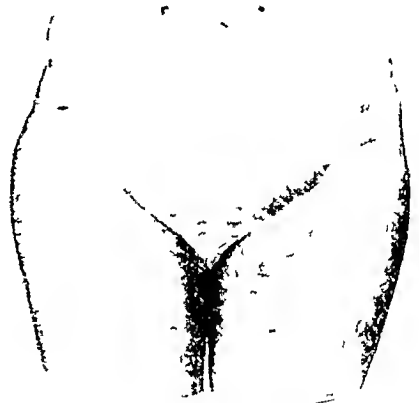


FIG 403 —FEMORAL HERNIA

of a reducible swelling with an expansile impulse on coughing. It is distinguished from it by the facts that there is no gurgle on reduction, that the abscess, as it passes under Poupart's ligament, lies to the outer side of and behind the vessels, and that distinct fluctuation occurs between the swelling in the saphenous opening and the tumour, which can always be felt in the iliac fossa, the characteristic signs of spinal caries are also usually present. (e) In *varix of the saphena*, if a pouch or so-called ampulla forms close to its entrance into the femoral vein, it may be mistaken for a femoral hernia on account of the marked impulse on coughing, and because the swelling disappears on assuming the recumbent posture. It is, however, usually associated with the signs of *varix* below, and by the fact that, although pressure is made over the upper part of the crural canal after the vein has been emptied, the swelling regains its ordinary size when the patient stands up.

**Treatment** —When reducible and of small size, a femoral hernia may be treated by the use of a *truss*, similar in nature to that used for an inguinal hernia, except that the pad extends somewhat lower, so as to maintain pressure along the course of the canal. A badly-fitting truss may compress the femoral vein, and lead to œdema of the leg.

**Operative Treatment** is undertaken either for the relief of strangulation, or, if a radical cure is desired, as an *opération de complaisance*. The remarks already made as regards the cure of inguinal hernia, and the general principles there enunciated, apply also to this variety

Two main methods of operating are employed (1) The apposition of the anterior and posterior walls of the crural canal, which practically resolves itself into the fixation of the inner end of Poupart's ligament to the horizontal ramus of the pubis or the structures overlying it. The sac is exposed by a vertical incision along the course of the crural canal (Fig 363, G), cleared of its fatty covering, which is often very extensive, emptied of its contents by reduction, and then cut away after transfixing and tying the neck. Some surgeons, however, retain the sac, pushing it back into the abdomen, and using it as a pad across the upper opening of the canal. The fatty covering of the sac must be dealt with in a similar way. The deep ring is then commanded by one of the following methods. In the great majority of cases it will suffice to introduce stitches through the inner end of Poupart's liga-

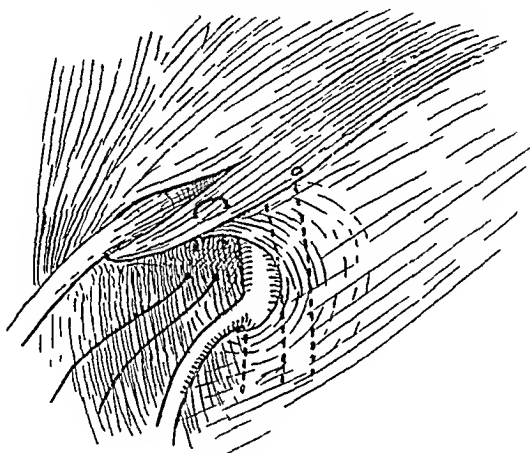


FIG 404.—DIAGRAM OF THE RADICAL CURE FOR FEMORAL HERNIA

The position of the femoral vein and artery is indicated and the internal saphena vein passes up through the saphenous ring to join the former. The spermatic cord is seen above, and the situation of the suture to close the crural canal.

ment (Fig 404), and deeply through the horizontal fibres of Cooper's ligament, which lie in close apposition to the horizontal ramus of the pubis. These give a sufficiently firm hold, whilst if only the fascia over the pectineus is taken up the grasp is anything but satisfactory. In bad cases, where the opening is larger, it may be desirable to approximate Poupart's ligament to the horizontal ramus by some firmer method, and for this purpose Roux has advised the use of a  $\cap$ -shaped metal staple, which traverses the ligament, and the free ends of which are driven into the bone. This plan appears to us undesirable, since the staple occasionally works loose, and then the proximity of the femoral vein makes it an unwelcome neighbour. A good substitute for this plan has been practised by Nicoll of Glasgow, who drills the horizontal ramus from below upwards in two spots, and then by passing a mattress suture through Poupart's ligament and the free

<sup>a</sup> *Scottish Med and Surg Journ*, December, 1903

ends through these drill-holes, tying them below, the ligament is safely approximated to the inner and upper aspect of the pubis (2) The plugging of the canal by tissue which shall heal into it and constitute a cicatricial barrier has also its advocates Mr Watson Cheyne dissects up a portion of the pectineus muscle, and fixes it in the crural canal by means of sutures He claims satisfactory results therefrom

**Umbilical Hernia** —Three different forms of umbilical hernia are described

1 **Congenital Umbilical Hernia, or Exomphalos**, is an exceedingly rare condition, due to imperfect closure of the abdominal walls, as a result of which the intestine is not entirely withdrawn into the abdomen at birth, but is found in a cavity at the base of the umbilical cord, which is bulbous and enlarged If the condition is overlooked, it may be included in the ligature with which the cord is tied, and fatal strangulation, or at the best a fæcal fistula, will result If left untreated until the cord has separated, the peritoneal cavity will be laid open, and septic peritonitis ensue The only treatment is immediate laparotomy, reduction of the gut, and closure of the umbilical opening by sutures

2 The **Umbilical Hernia of Infants and Young People**, or, as it is commonly called, 'starting of the navel,' is due to weakness of the umbilical cicatrix, which yields before the intra-abdominal pressure Its occurrence is often determined by chronic constipation or phimosis, necessitating continual straining in order to evacuate the bowels or bladder The condition rarely persists till adult life is reached, and it is readily amenable to treatment This consists in regulating the bowels, and the performance of circumcision, if necessary, whilst the local condition is dealt with by strapping the abdominal wall in such a way as to tuck the umbilical cicatrix inwards, no pad is required In persistent cases it may be necessary to lay the sac open and remove it, suturing the parts together, as described in detail below In these cases the opening is often a transverse chink rather than a round hole, and it is sometimes advisable to introduce the sutures in a vertical direction, thereby securing transverse apposition

3 The so-called **Umbilical Hernia of Adults** is usually due to a protrusion of omentum or intestine through an opening in the linea alba, either immediately above or below the umbilicus, the former being the more common It occurs most frequently in women who have borne children, being sometimes due to actual rupture of the linea alba and separation of the recti muscles In such cases it is possible that the peritoneum is also torn, and the intestines extravasated, as it were, beneath the skin A peritoneal sac is, however, usually seen, but in old-standing cases it is extremely attenuated, and so adherent to surrounding parts as to be unrecognisable, whilst the contents may be matted together in an almost inextricable confusion In such cases obstruction is very liable to ensue, and if combined, as is not uncommon, with a subacute form of inflammation, it may even run on to strangulation Moreover, the skin over the tumour becomes



stretched, atrophic, and not unfrequently ulcerated, so that perforation may threaten. The hernia is often lobulated in character, and a considerable deposit of fat may sometimes surround it.

**Treatment** — When of large size, and occurring in stout individuals, it should be supported by a bag truss, whilst the patient is placed on such dietetic and hygienic measures as shall assist in the reduction of excessive corpulency. In favourable cases operative treatment can be undertaken. A vertical incision is made over the site of the tumour, and to effect this without wounding the subjacent gut, it may be advisable to pinch up the skin on either side, and cut it by transfixion. The sac is then opened, the incision being enlarged, if necessary, so as to allow the contents to be drawn aside and the opening in the abdominal wall exposed. When the intestine has been reduced and omentum removed, the sac is dissected up to the margins of the opening into the abdomen, which is usually small in size and circular in shape, whilst the edges are firm and thickened. The sac may now be cut away close to the opening, and all bleeding points secured. The aperture is then closed in the following way. Several deep transverse sutures are passed through the whole thickness of the abdominal wall on each side, and tightened after a row of interrupted sutures has drawn the peritoneal surfaces into contact. By this means the circular aperture is obliterated and the margins united in the median line. The external wound may now be closed, any redundant skin being cut away, it is usually safer to insert a drainage-tube in the more extensive cases.

Most surgeons have discovered by experience that such a procedure is inefficient in any but the slightest cases, and that a much more radical operation is required when the hernia is large and irreducible, and the patient at all inclined to corpulence. (1) The early steps of the operation are identical, but it will be found advantageous to place the cutaneous incision to one side of the tumour rather than over its centre. The freeing of the omentum may be a matter of great difficulty, as it is often adherent to the margins of the opening. (2) It will then be found that the anterior layer of the sheath of the rectus is prolonged over, and soon lost on the sac. An incision is made all round the neck of the sac through this aponeurotic covering to reach down to the subperitoneal tissue, stitches are now introduced across the opening through the peritoneum and this aponeurotic ring in order to effect its closure, all redundant sac is clipped away with scissors, bleeding points being secured or divided. (3) The recti muscles are now laid bare on either side, and their posterior surfaces and edges loosened so that they, together with the anterior layer of their sheaths, can be brought into apposition over the closed neck of the sac, which is thereby buried. To do this effectively the incisions may have to be prolonged up and down the abdominal wall for some distance, since the recti are usually displaced outwards some way above and below the opening. Silkworm gut may be advisably used to bring the margins together. Redundant skin is now cut away with a free hand, so that the abdominal integument may not be

unduly lax, but shall just cover the muscles comfortably. In fat patients this may involve the removal of considerable masses of fat.

An operation of this type is a severe one, and not to be lightly entered upon, but if it is carefully conducted, the results in many cases are most successful. Of course it is very desirable that the patient should not put any strain on the abdominal wall for some time; she should rest in bed for six weeks after the operation.

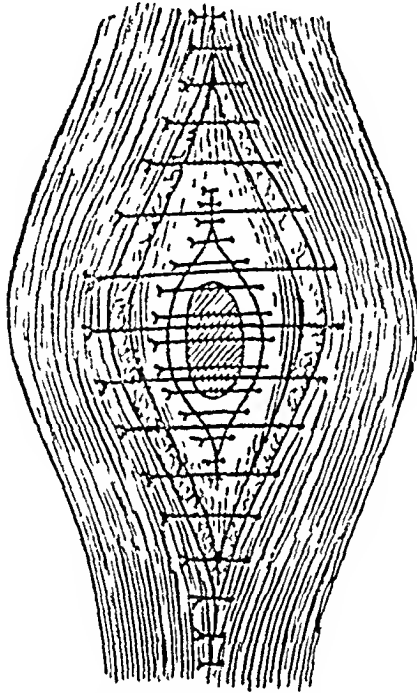


FIG. 305.—DIAGRAMMATIC REPRESENTATION OF THE RADICAL CURE OF AN UMBILICAL HERNIA WHEN THE RECTI MUSCLES ARE CONSIDERABLY DISPLACED.

The short cross lines represent the sutures which close the opening in the peritoneum; the long ones, the sutures needed for apposing the edges of the recti muscles and the anterior walls of their sheaths.

A **Ventral Hernia** is the term used in describing any protrusion occurring at some spot in the anterior abdominal wall other than those already mentioned. Several forms may be met with.

1. It not uncommonly consists of a protrusion of subserous fatty tissue through a congenital or acquired opening in the linea alba, lineæ semilunares, or lineæ transversæ, especially at the junctions of the last with the former. They are more common above than below the umbilicus, and if, as not unfrequently happens, the fatty tissue proliferates, a localized tumour resembling a lipoma is produced, which goes by the name of a 'fatty hernia of the linea alba'. A portion of peritoneum is drawn through the opening into the centre of these masses when they have persisted for some little time, and a true

hernia is thus induced. A similar condition is met with in the inguinal and crural regions, and probably most of the cases described as lipomata in these parts are of this nature. Considerable pain and abdominal disturbance (vomiting, colic, etc.) accompany almost every movement of the body, being caused partly by the traction of the peritoneum, partly by the constriction of the neck of the sac against the sharp edges of the small opening. *Treatment* consists in the removal of the projecting mass, care being taken not to include any viscera in the suture with which the base is surrounded. The stump is pushed back into the abdomen, and the opening closed by deep sutures.

2 After operations involving the division of the abdominal parietes, ventral hernia may be caused by the yielding of the cicatrix, especially if the wound suppurates, and the deep stitches come away or are removed, or if the opening is left patent for the purpose of draining an intra-abdominal abscess. *Treatment* of such cases consists in dividing the skin and subjacent fibrous tissues, defining and refreshing the edges of the parietal wound, and drawing them together with buried sutures. The peritoneum need not always be opened in such a procedure, but it is sometimes wiser to do so. Especially is this the case when a ventral hernia forms after an operation for suppurative appendicitis, the appendix is not unfrequently left at the primary operation, and the surgeon may rightly take the opportunity of removing it during the operation required for the cure of the hernia.

3 In women who have borne children the linea alba often stretches and yields, allowing considerable separation of the recti muscles for almost their whole length. If placed in the recumbent posture, and told to raise their head and shoulders from the bed without using their elbows for support, the linea protrudes as a longitudinal ridge of considerable breadth. Much discomfort and dyspepsia arises from this cause, owing to the inefficient support given to the intestines. A firm abdominal belt may be useful as a palliative measure, but operation is very desirable. The thinned linea alba is split down the middle from top to bottom if need be, on one side—say the right—it, together with the neighbouring rectus muscle, is separated from the subcutaneous tissues and tucked under the rectus on the left side, its free end being secured by mattress sutures passing through its edge and the left linea semilunaris, and being tied superficially. The left free edge is subsequently secured to the right linea semilunaris by a row of stitches. In this way the abdominal wall is drawn together like a double-breasted coat, and excellent results follow.

**Lumbar Hernia** is a condition of considerable rarity, in which the abdominal viscera protrude by the side of the erector spinæ, coming to the surface between the latissimus dorsi and the external oblique, in the space known as Petit's triangle. The ordinary signs of a hernia are present, and with a little care the condition is readily distinguished from a lumbar abscess. *Treatment* may be conducted along the same lines as for a ventral hernia.

**Diaphragmatic Hernia** is rarely recognised *ante-mortem*. A few cases of strangulation have, however, been diagnosed. It is usually

congenital in origin arising from imperfect development of one or both halves of the diaphragm, and is most common on the left side. It may, however, result from traumatic lesions, such as stabs, involving the diaphragm. The transverse colon or stomach generally protrudes into the thorax and there is usually no peritoneal sac. *Treatment* is impracticable in the majority of instances, although one or two cases of traumatic hernia have been successfully operated on through the chest wall and pleural cavity, thus permitting the closure of the hole in the diaphragm.

**Obturator Hernia** consists in a protrusion of intestine through the upper part of the thyroid foramen, and has usually been observed in elderly females. It is not often recognised in the living, except when strangulated and even then, unless of considerable size, it is likely to be overlooked. It has, however, been diagnosed by the fact that, in addition to the general signs of strangulation, there was a sense of deep resistance and of fulness close to the origin of the adductor muscles whilst pain was referred down the obturator nerve to the inner side of the knee. Rectal or vaginal examination may throw some light on the nature of the case. *Treatment* has generally been confined to cases of strangulation, and in these an incision is made over the inner aspect of Scarpa's triangle, and the pectineus divided or displaced. The sac when found should be opened, and strangulation relieved by cutting upwards, the obturator vessels being usually situated below the neck of the sac.

Other forms of hernia, *e.g.*, pudic, pudendal, vaginal, sciatic, etc., have been described, but are so uncommon that they need no special mention.

### Abnormal Conditions of Herniæ

**Irreducibility of a Hernia** is generally due to the presence of adhesions, either between the contents and the sac, or between the contents themselves, which are thus united into a mass too large to pass through the aperture of communication with the abdomen. This is often associated with contraction of the neck of the sac, which arises either from the pressure of an ill-fitting truss or the constant drag of the contents. Overgrowth or an excessive deposit of fat in the omentum may result in irreducibility, whilst cysts may occasionally form, as already described.

The local signs of this condition are very evident, whilst dyspepsia, colicky pains, and a sense of dragging are among the most prominent symptoms.

**Treatment**—1 It may sometimes be remedied by *forcible taxis* applied at intervals, between which the patient is kept in bed, and an icebag applied so as to contract the parts, moreover, the patient, if fat, should be carefully dieted. It is most important not to operate on large herniæ of this nature until some such preliminary treatment has been undertaken, the sudden reduction of a large amount of intestine into the abdominal cavity has been responsible for several deaths from interference with the heart's action. 2 Another plan

consists in the use of what is known as the *hinged-cup truss*, the hernia is supported in a suitable leather bag hinged to the lower part of a truss, upward pressure being maintained by means of an elastic spring. By the use of one or other of these plans reduction may after a time be accomplished, but we are not in favour of any such proceedings, except in very large herniæ. 3 In healthy individuals, and if the rupture is not too large, operation is preferable and much more satisfactory, omentum being removed and adhesions divided, as already described. 4 In a few very aggravated cases, it is only possible to support the hernia by an elastic bag.

**Inflamed Hernia** is one characterized by the existence of a localized peritonitis involving the sac, and perhaps also the contents. It usually arises from injury, such as ill-directed taxis, or from injudicious truss pressure. The symptoms are those of a local inflammation, the part becoming hot, painful, tender, and swollen, and perhaps the skin over it congested, this is associated with general fever, malaise, nausea, and vomiting, whilst constipation is usually present. A condition is thus induced somewhat resembling strangulation, but it is distinguished from the latter by the presence of fever instead of shock, the absence of tension in the sac, and the character of the vomiting, which is not fecal. The hernia is irreducible, at any rate for a time, probably more on account of the pain, which prevents taxis, than from any mechanical reason, except in old-standing cases where previously formed adhesions exist. Lymph is deposited on the serous surfaces, and this usually leads to the formation of adhesions. Occasionally, where omentum is alone present, an attack of this type may result in a natural cure, especially in the umbilical variety.

The **Treatment** consists in putting the patient to bed and restricting his diet to fluids, whilst fomentations are applied to the part. A little opium may also be administered to allay the pain, and possibly the lower bowel emptied by an enema.

**Obstructed Hernia** is a condition in which the onward passage of feces through the gut contained in a hernial sac is prevented. It is most frequently seen in the umbilical variety, and, of course, only involves the large gut. It is due to an accumulation of undigested food or feces, the condition being aggravated by the presence of flatus derived from the decomposition of the contents of the bowel. Nausea and vomiting are induced, the latter, however, rarely becoming feculent, whilst constipation is usually present, although the lower bowel may empty itself and flatus may pass. Locally, the tumour becomes irreducible and distended, but not tense as in strangulation, and a doughy mass, which can be moulded and indented by the fingers, is felt within the sac. There is no tenderness, but the patient usually complains of a good deal of intermittent colicky pain. If unrelieved, a subacute form of inflammation may supervene, and this may pass on to strangulation, and even death.

**Treatment** consists in the use of copious enemata, and the application of an icebag to the hernia, followed by carefully-applied taxis, so as to assist the onward passage of the impacted contents. As soon as the obstruction is overcome, a brisk purge should be administered.

## Strangulated Hernia

A hernia is said to be strangulated when the contents are constricted in such a way as to obstruct and ultimately arrest the flow of blood in the vessels contained therein. Interference with the passage of fæces is not an essential in this condition, since omentum alone may be involved, or the intestine, if present, may only have a portion of its lumen constricted, as in the form known as **Richter's hernia**, whilst in **Littre's hernia** a diverticulum is similarly affected.

Two chief varieties of strangulation are described: those occurring within the abdomen, which are dealt with more fully in Chapter XXXVI, and those which are extra-abdominal, it is only the latter to which we shall now direct attention.

**External Strangulated Hernia** arises in one of two ways: (a) The hernia becomes strangulated immediately after its formation, this is most frequently seen in children or adolescents, the hernia being then of the congenital type, and having a long narrow sac. (b) In adults it more frequently results from extrusion of an additional amount of the abdominal contents into the sac, as the result of some sudden violent effort. This condition usually obtains in old-standing herniæ, the neck of the sac having previously become thickened and contracted, either by the pressure of a truss or the irritation of the protruded viscera. The former of these two conditions is usually acute in character, the latter more often subacute.

The site of the constriction is either at the neck of the sac, or in the dense tissues external to it (Fig 406), but occasionally it exists elsewhere. Most frequently the active agent in the strangulation is the thickened sac wall itself, but in femoral and umbilical herniæ structures outside the sac, such as Gimbernat's ligament or the linea alba, may be the actual cause of the constriction, whilst it may also be produced by the passage of a coil of intestine under a tight adhesion or through a slit or aperture in the omentum contained in the sac. In those herniæ which become strangulated immediately after

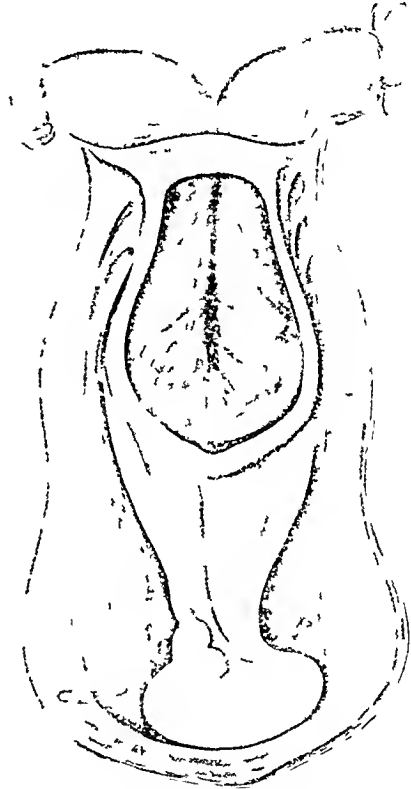


FIG 406—STRANGULATED INGUINAL HERNIA

their protrusion, the constricting cause is invariably the resistance of the tissues surrounding the opening in the abdominal parietes

**Pathological Phenomena** — The effects of strangulation vary somewhat with the tightness of the constriction. The circulation is seldom entirely arrested at the onset of the symptoms, but the pressure affects first, and more especially, the veins, and later, by the congestion and exudation thus produced, the flow in the arteries is brought to a standstill. Hence the constricted tissues are congested to begin with, and then, partly as a result of the deficient supply of arterial blood, mainly in consequence of bacterial invasion, gangrene ensues, with or without an intermediate period of inflammation.

When a *portion of intestine* is strangulated, the following changes manifest themselves in its structure and appearance. At first it becomes of a dusky red, chocolate, or claret colour, owing to vascular congestion, it is thickened and stiff from exudation into its walls, and distended by the formation of gas within its lumen, owing to the arrest of peristalsis and the putrefaction of its contents. The surface at first remains smooth and shiny, but as the exudation into the sac increases, the endothelium is usually shed. Occasionally some of the superficial capillaries rupture, giving rise to ecchymoses, whilst in rarer instances, and possibly as the result of injudicious taxis, the congested vessels completely empty themselves into the sac, which is thus filled with clotted blood, the intestine in consequence becoming lax and yellowish-gray in colour. When the strangulation is relieved in this early stage, the bowel soon regains its former healthy appearance. If inflammation occurs, the surface becomes rough from the deposit of lymph, and entirely loses its shiny and polished aspect. Gangrene results partly from the prolonged stagnation of blood, and partly from the invasion of the intestinal wall by the *B coli* and other anaerobic inhabitants of the gut, which, as soon as the vitality of the intestinal wall is sufficiently impaired, migrate through it, and by their development produce toxic bodies which still further assist the gangrenous process. As soon as it is established, the intestine turns an ashy gray or black colour, usually at one or more spots which gradually spread, lose all lustre and polish, and after a time become soft, lacerable, and offensive. Gangrene\* is much more common in the femoral and umbilical forms of hernia than in the inguinal, it is generally developed in two or three days, but occasionally may supervene in less than twenty-four hours from the onset of the strangulation. It is more usually seen in small herniæ of recent origin than in large old-standing ones. At the point of strangulation the gut is completely anæmic and liable to ulceration or gangrene, which may subsequently result in perforation, adhesions may, however, form between it and the neck of the sac, thus preventing contamination of the general peritoneal cavity. The intestine above the site of strangulation becomes paralyzed, and peristalsis is entirely arrested, even in a Richter's hernia. Fæcal material, accumulating and undergoing decomposi-

\* For a valuable paper on 'Gangrene in Strangulated Hernia,' see Corner St Thomas's Hospital Reports vol viii

tion, gives rise to a catarrhal enteritis, and even occasionally to ster-coral ulcers, which may perforate and cause general peritonitis, this, however, is not very common in external strangulation, since the small intestine is usually involved, and solid fæces are absent. In more chronic cases gangrene of the gut may be induced by the pressure of the accumulated contents and the action of the *B. coli*. The portion of the bowel *below the constriction* may be affected in a similar manner, owing to the arrest of the peristalsis, but to a slighter degree.

When strangled, is at first congested and of a dark red or purple colour, and later on infiltrated and matted together. If, however, it has contracted adhesions to the sac, and no gut is present, the trouble may subside, since its vitality may be maintained through the adhesions, and a natural cure of the hernia may result. Where such a condition is not present, gangrene supervenes, and the omentum then becomes ashy gray or brown in colour, and is pultaceous and friable. It does not become offensive unless associated with intestine, since it does not contain any intrinsic source of putrefaction.

The *sac* is usually distended with fluid, which at the commencement is serous in character, and perhaps blood-stained, whilst subsequently it becomes turbid and mixed with lymph, finally, it is dark brown or yellowish green, with a marked and most objectionable odour. Occasionally there is but little or no effusion of fluid, a condition usually due to complete strangulation of arteries and veins simultaneously, and often the precursor of early gangrene. The serous lining of the sac is but slightly affected in the early stages, as, however, the case progresses to inflammation or death of the contents, it also becomes inflamed, and ultimately gangrenous from the activity of bacteria, which by this time have penetrated to the turbid serum contained within it. The skin and surrounding tissues become œdematous, congested, and crepitant, and, finally, a natural cure may be determined by sloughing and the establishment of an artificial anus.

After the relief of strangulation, even if no gangrene has occurred, the patient is not free from risk, owing to changes which may possibly follow the temporary arrest of the circulation. It has been shown by placing a ligature around the ear of a rabbit that the amount of reaction, when the constriction is relieved, varies directly with the tightness with which the ligature has been applied, and with the period of constriction. When applied loosely and only for a short time, the restoration of circulation is followed merely by a transient hyperæmia, but as the completeness and duration of the obstruction are increased, the inflammation becomes more and more intense, and even gangrene may ensue. Similar results follow the relief of strangulated hernia. In the less severe cases the intestine merely becomes temporarily congested, but in the more acute forms the paralysis of the gut may persist, whilst inflammation, possibly running on to gangrene, may be produced, either in the strangulated portion or in that immediately above, or in both, and thus, although the operation has been skilfully performed, the patient may succumb.

The **Clinical History** of a case of strangulation is usually so char-



acteristic that there can be but little uncertainty as to the diagnosis. The *general* symptoms are similar to those described at p 1104, as occurring in all cases of acute intestinal obstruction. The patient during some sudden effort notices a severe pain, localized at first to one of the hernial regions, or referred to the umbilicus, this is accompanied by the usual evidences of shock, *i.e.*, he feels faint, the pulse becomes slow and weak, the temperature falls, and the surface is covered by a cold, clammy sweat. This shock is often not very prolonged, and is associated with or quickly followed by vomiting, at first gastric, then bilious, and finally stercoraceous or fæcal. As this continues, the pain increases in severity, and radiates over the whole of the abdomen, which becomes tense, tender, and tympanitic. Symptoms of exhaustion supervene, caused partly by the pain and vomiting, and partly by the inability to take food, probably the absorption of toxic material from the intestines also assists in its production. Complete constipation is usually present, but the patient may pass flatus or fæces from the lower part of the intestine. The onset of gangrene is generally accompanied by a sudden fall of temperature and a cessation of pain, whilst the pulse becomes weak, rapid, and intermittent, the surface is covered by a cold sweat, the countenance becomes shrunk and drawn (the so-called 'facies Hippocratica'), hiccough follows, and finally the patient dies, usually as a result of toxæmia due to the absorption of products developed either in the bowel wall or sac, or in consequence of acute generalized peritonitis.

*Locally*, the onset of the symptoms is associated with the formation of a tumour in one of the usual sites of a hernia, or if already the subject of this condition, the patient may notice that his rupture has suddenly become larger. The swelling is irreducible, tense, extremely tender and painful, and without impulse on coughing. It is hard and rounded if bowel is involved, softer and more doughy to the touch, if omentum. When gangrene ensues, the tension within the sac is reduced, pain and tenderness cease, whilst the skin over the tumour becomes dusky, inflamed, and œdematous, finally, evidences of gangrene show themselves externally, the parts becoming dark in appearance, and soft and emphysematous to the touch. If the patient survive, the necrotic tissues separate, and an artificial anus is produced either naturally or through the intervention of the surgeon. Suppuration within the sac is uncommon.

Occasionally, however, cases are met with in which the above-described signs are considerably modified, and gangrene of the gut may occur without the exaggerated phenomena of a serious toxæmic type indicated above. In one of our cases the patient complained of no inconvenience beyond slight pain, although incipient gangrene was present, he walked into hospital saying that he never felt better in his life.

The early symptoms arising from strangulation of a portion of the lumen of the intestine (*Richter's hernia*) are sometimes less marked than when a complete loop is constricted, but the later phenomena

are always very severe. It is usually of the femoral variety, and the ileum is most frequently involved. If less than half the circumference of the bowel is constricted, the obstruction is not always complete at first, flatus and fæces being sometimes passed, but where more than half the circumference of the bowel is engaged, complete obstruction from kinking or paralysis of the gut ensues. The vomiting is less marked than in other cases, and is not so commonly fæculent. The tumour produced is small in size, but tense and tender. The prognosis in these cases is always grave, partly from the difficulty experienced in diagnosis, partly from the tightness of the constriction, death usually results from perforative peritonitis, which is occasionally due to wounding of the gut by the hernia knife. The mortality in these cases is calculated at 62 per cent, which is in marked contrast with that of about 35 per cent, which is usually said to be characteristic of strangulated hernia. Our mortality for all cases of strangulated hernia admitted to King's College Hospital during the years 1892 to 1897 only amounted to 16.6 per cent.

The occurrence of *strangulation in a pure epiplocele* is very rare, the symptoms are vague in character, and the diagnosis is often difficult. The presence of a soft, doughy, tender swelling in any of the hernial regions, combined with pain, bilious vomiting, and possibly constipation, is always a significant feature. So long as no kinking of the bowel is caused thereby, the symptoms may remain indefinite, the vomiting never becoming fæcal, but as time goes on, arrest of peristalsis may lead to true obstruction, or even general peritonitis. As already mentioned, strangulated omentum does not *per se* become offensive, but occasionally a neighbouring coil of intestine may be dragged upon, and its circulation disturbed sufficiently to enable the *B. coli* to escape, and then it may find its way into the sac, and develop therein its characteristic odour without any serious lesion of the intestine or peritoneum being conjoined.

The **Treatment** of a strangulated hernia consists in reducing the contents by taxis, or by operation.

**Taxis** is the term employed for the manipulation by means of which a hernia is reduced. In cases of strangulation, it must be used with gentleness and great care, since the involved portion of intestine is congested and easily torn. The patient is laid on a couch with the head supported, and the thighs slightly flexed, so as to relax the abdominal muscles. The fundus of the tumour is then grasped with one hand, and steady pressure employed, having for its object the emptying of the congested bloodvessels, and consequently a diminution in the size of the hernia, the fingers of the other hand manipulate the neck of the sac, in order that the part which has most recently been protruded may be first returned. The direction in which taxis is made varies in different cases. In inguinal hernia, it should be directed upwards, outwards and backwards. In a femoral hernia which has extended beyond the saphenous opening, taxis is first employed downwards and inwards in order to make the gut re-enter the crural canal, and then finally backwards and upwards, the margins

of the saphenous opening being relaxed by flexing and slightly inverting the thigh. In umbilical hernia, the pressure is mainly directed backwards.

Whilst admitting that taxis has a place in the treatment of strangulated hernia, we feel that that place should be carefully defined and limited. In the past it has been used injudiciously, and in cases where it could not be expected to do any good, the bowel has sometimes been ruptured or its wall bruised, the mesentery torn, and other serious results have followed. At the present day operative treatment for hernia is eminently successful, and open exploration of the sac enables one to judge of the condition of the gut and prevents the likelihood of returning to the abdomen an infected and even gangrenous focus. Hence we would conclude that *taxis is permissible* when the hernia is of large size, particularly when inguinal, when the symptoms have a mild onset and do not become severe, and especially if taxis has been successful on former occasions. *Taxis is objectionable*, and if employed at all should be used in the most perfunctory fashion, when the hernia is small and very tense, and particularly if femoral, when the onset is acute and sudden, when the symptoms are well marked, and especially if they become so in the early stages of the case, if strangulation follows on the first development of the hernia, and of course if the case has lasted for some time and fæcal vomiting is present. A final attempt may always be made before operation when the patient is anæsthetized.

In some of the slighter conditions of strangulation, and especially if the patient has had similar attacks before which have been relieved without operation, reposition may be assisted by applying fomentations for half an hour, followed by the use of an icebag, reduction sometimes taking place spontaneously or being brought about by taxis. The heat relaxes the tissues around the neck of the sac, and the effect of the cold is not only to constrict these tissues, but also to induce contraction of the intestinal bloodvessels and muscles.

**Persistence of Symptoms after Apparently Successful Taxis**—It happens occasionally that although the surgeon may have apparently reduced the hernia satisfactorily, the symptoms of strangulation, viz, pain, vomiting, and constipation, persist. Such may be due to a variety of conditions, and considerable judgment is needed in coming to a correct decision in any particular case. (i) Infective gangrene may involve the released coil of gut and spread to the portion above it, causing death from peritonitis and toxæmia. (ii) Ulceration and perforation may occur along the 'constriction groove'. (iii) The rupture reduced may not be the one which has given rise to the symptoms, an internal hernia, or one in some other region, co-existing. (iv) The strangulation may have been caused, not by the neck of the sac, but by a slit in the omentum contained in the sac. Reduction in such a case would not relieve the symptoms, the whole mass being returned into the abdomen. (v) The hernial sac may have a diverticulum or pocket communicating with it at its upper end (intraparietal interstitial hernia), or it may be shaped like an hour-glass.

It is possible to reduce the intestine from the lower portion of this so-called *herma en bissac* into the upper pocket, and then of course the symptoms persist (vi) Reduction *en bloc* or *en masse* ought never to be seen, as it can only occur when considerable, and therefore injudicious, force has been employed. The sac and its contents are together reduced from their superficial position to the deep aspect of the abdominal parietes, the hernia then lying between the muscular planes or in the subserous areolar tissue, and the constriction remaining. The hernia gradually disappears, but without the characteristic gurgle. In such a case the sac sometimes gives way, the intestine and the portion of the neck which compresses it being pushed upwards. When occurring in the inguinal region it is recognised by the persistence of symptoms, and by the fact that a finger inserted into the canal, which is unduly patent, detects a tense rounded swelling at its upper end. It also occurs, but less commonly, in the femoral region, and in either variety the hernia may slip down again a short time after its apparent reduction.

In any case where, after an apparently successful taxis, the symptoms of strangulation are still present, a most careful investigation is needed in order to ascertain, if possible, the cause. Thus, the character and frequency of the vomiting must be considered, since it may be due to the anæsthetic, but then loses its fæcal character, and is less severe. If the vomiting is associated with a certain amount of local pain, and possibly with some blood stained diarrhœa or the passage of mucus, the probability is that the coil of gut has been in reality reduced, but has subsequently become inflamed. Apart from such indications the affected region must be thoroughly explored with the finger, so as to ascertain whether any tumour can be felt at the upper or deeper end, as occurs in reduction *en masse*. Should this throw no light upon the case, the other hernial apertures must each in turn be examined, and finally an incision is made over the supposed site of strangulation, and an exhaustive search made for the sac. If no help is thus obtained, the abdomen must be opened, and some internal complication sought for. In the inguinal region, all that is needed is to prolong the first incision upwards and outwards, in a femoral hernia, it is perhaps wiser to make a separate laparotomy wound in the middle line, so as to avoid the division of Poupart's ligament, whilst in the umbilical variety, the requirements of the case are met by simply increasing the size of the communication between the sac and the abdominal cavity.

The **Operative Treatment** of strangulated hernia should always be undertaken at as early a date as possible, when once it is certain that the bowel is constricted. Nothing can be gained by waiting, whilst even the delay of an hour may make it doubtful whether the result will be successful or not. There is always sufficient time to permit of efficient purification of the parts, whilst it may be desirable to empty the lower bowel by an enema, and if there is much vomiting to wash out the stomach. The administration of an anæsthetic needs care, and in the worst cases local anæsthesia must be depended on

(see p 1309) A suitable incision is then made down to the sac, which should be recognised by its tense and rounded outline. It is isolated as far as possible from surrounding structures, and then carefully opened. The amount of fluid varies much, and is some times very small, so that the possibility of injuring the bowel must be kept in mind. Having given exit to the fluid from the sac and noted its characters, the surgeon carefully examines the bowel or omentum. The cause of strangulation is then looked for and divided by a special hernia knife, which practically consists of a curved blunt-ended bistoury, the cutting blade being limited to an extent of about  $\frac{3}{4}$  inch from the blunt end. If such is not to hand, an ordinary curved bistoury will suffice. The index-finger is employed to repress and guard the intestine, and acts better than a director, since intestine is likely to curl up on either side of the instrument, and may thus be injured. The knife is then slipped on the flat under the constriction, and turned so as to divide it, ~~it is better to nick it~~ slightly in two or three places than to incise it by one deep cut, as is often recommended.

The gut is drawn down into the wound, and its condition at the site of strangulation carefully examined, it is sometimes a matter of great difficulty to decide whether it should be returned or not. Of course when gangrene is obviously present it is out of the question, but in many cases the condition of the bowel is doubtful. It is then well to delay action for a few minutes, and perhaps douche the parts with warm salt solution. A gradual change of colour from a deep claret to a more definite red indicates that the circulation is still active, occasionally, however, it will be found that no change occurs in spite of division of the constriction, or that the admittance of the circulation brings into evidence patches here and there that remain unaltered, these are probably gangrenous, and it is wise to deal with them as such. Omentum, if small in amount and recently prolapsed, may be reduced, but it is better practice to remove any congested portion, or that which has evidently been in the sac for some time. The method of its removal has been already described (p 1076).

According to the condition of the intestine, the further steps of the operation are modified as follows

- 1 If the gut, though congested, shows no sign of gangrene or perforation, it may be safely reduced. This is not always a matter of ease, owing to the fact that the effusion into its walls has made it stiff and firm. Prolonged and steady pressure with the fingers will, however, sufficiently remove the exudation to permit of its reposition into the abdomen. All manipulation directed to the intestine must, of course, be of the gentlest nature, since its congested state makes it more friable than usual.

- 2 If the gut has been tightly strangled and gangrene is threatening, and especially if this is the case at an early stage, it may be advisable to resect it at once, the incisions being made well above and below the sites of constriction, the divided ends are united by one of the plans detailed at p 1026. If, however, the bowel is in a doubtful

condition, but recovery thought possible, it is gently replaced just inside the abdomen, after freely dividing the constriction, and a large drainage-tube is inserted down to it. There is no need to fix the bowel, it is already inflamed and paralyzed, and hence will not change its position, especially if a small dose of opium is subsequently administered. In this way, even if gangrene or perforation occurs, a track is left for the escape of the contents, while a localized plastic inflammation will shut off the general peritoneal cavity. A fæcal fistula may thus be formed, but it often closes spontaneously at a later date.

3. If the gut at the time of operation is evidently gangrenous, the ideal treatment consists in (a) *total removal of the affected coil*, and of some inches below and above it, especially the latter, so as to be well clear of the infected focus. The ends are united together in the usual way, and a considerable degree of success may be expected in patients who have not been left too long. The intestinal canal is at once restored to functional utility, so that the fluid and offensive fæcal material can pass onwards, whilst the absorption of toxins from the stinking gangrenous gut wall is stopped. (b) In only too many of these cases, however, the general condition is almost hopelessly bad through delay, and primary enterectomy, even in expert hands, takes some time. It is then necessary to open the bowel and make an *artificial anus*. It is essential that a free passage should be made under the constriction into the gut above, but if possible without detaching or loosening adhesions at the neck of the sac, whereby peritoneal infection is prevented. The introduction of the finger up the bowel may be followed by a free flow of fæces, but if not, then the constriction may be dilated from inside the bowel by dressing-forceps and a large drainage-tube introduced, or the constriction at the neck may be carefully divided from outside, and either a Paul's tube or a large drainage-tube inserted. Of course, one should cut away as much of the stinking gut as practicable. An artificial anus is thus formed, through which for a time the patient can discharge the intestinal contents, and unless this desideratum is at once attained, failure is very likely to follow the operation. The wound is left open and a suitable dressing applied, into which the fæces can be received, possibly the best application is a layer of protective with a sufficient hole in the centre to allow the fæces to pass, and then over it a thick layer of tenax.

The relative value of the two methods cannot be fairly measured by statistics, since so many of the cases treated by the formation of an artificial anus are hopeless from the beginning. There can be no question that, with our present methods of intestinal suture, a large measure of success may be expected from the adoption of primary resection in the majority of cases.

Having thus dealt with the hernial contents, it is always advisable to perform a radical cure in uncomplicated cases, so as to prevent any recurrence of the condition. This is undertaken according to the methods already described, and the external wound subsequently closed and drained.

The **After-Treatment** in cases of strangulated hernia is of the greatest importance. The patient is placed in bed, and absolute quiet is maintained, no food being allowed for twenty-four hours, although a little ice may be sucked or hot water sipped in order to relieve thirst. If there is no pain, opium need not be administered, as it helps to maintain the paralyzed condition of the bowel, severe pain may, however, call for the hypodermic injection of a small dose of morphia. Liquid food can usually be taken at the end of twenty-four hours, and, if the patient's condition remains satisfactory, it is unnecessary to administer any purgative, the bowels often acting naturally, if they remain unrelieved for five or six days, a dose of castor oil should be given.

Various **Complications** may arise after the operation, needing special notice. (1) *Vomiting* may persist for a time as a result of the anæsthetic. It loses, however, its fæculent character, and may generally be stopped by washing out the stomach or by the hypodermic injection of morphia. (2) The *Paralytic* condition of the gut may remain for some considerable time, causing prolonged constipation. If there is no evidence of inflammatory mischief, it is best treated by the administration of a purgative or by a turpentine enema. (3) *Acute Enteritis* may arise either in the portion of strangulated gut or just above. This is usually indicated by localized pain, and perhaps the passage of mucus, which may be so abundant as to amount to diarrhœa, the vomiting, moreover, persists, but is no longer stercoraceous. It is best treated by the administration of bismuth combined with morphia, whilst all solid food is interdicted. (4) It is possible that although the gut looked healthy at the time of operation, its walls were in reality already infected, and in spite of the relief of the constriction, *infective gangrene* may follow, causing death from peritonitis. (5) Occasionally acute septic peritonitis results from a localized perforation, either of a small gangrenous patch or from ulceration along the 'constriction groove'. **Treatment**—The condition is obviously one of the gravest import, and must be dealt with actively if the patient is to be saved. The abdomen must be opened, the affected coil identified, and if need be resected, or fixed in the wound and opened for drainage purposes. The peritoneal cavity itself is dealt with according to the rules already given. (6) *Localized Peritonitis* may be looked on as a conservative measure, whereby Nature isolates some focus of danger from the general peritoneal cavity. Occasionally localized suppuration follows as the result of a limited ulceration or perforation of the gut, the pus must then be let out at the earliest possible moment, but a fæcal fistula is very likely to follow.

It is impossible to describe in detail every form of strangulated hernia. A few facts, however, must be stated about the more important varieties. In **Strangulated Inguinal Hernia** the constriction most commonly occurs at the neck of the sac, usually close to the external abdominal ring, as a result of the condensation of the surrounding tissues. The signs are usually very characteristic, and

Division of the stricture in the course of the operation is always performed in a vertical direction, the surgeon cutting directly upwards, the reason being that it is impossible in old-standing cases to be certain whether the hernia is oblique or direct, and thus the liability to injury of the epigastric artery is diminished.

Where the constriction is very tight, so that it is almost impossible to pass a director between Gimbernat's ligament and the intestine, the plan already mentioned of dividing the constriction from without may be utilized with advantage.

Gangrene is more than twice as common in femoral hernia as in inguinal (19.5 per cent in femoral against 6.1 per cent in inguinal). Where enterectomy is feasible, it will often be necessary to open the abdomen by an additional incision above the pelvic brim, and then, having divided the constriction at the neck of the sac, the affected coil must be slipped back and pulled out of the upper wound, the greatest care being taken not to contaminate other coils of intestine. The shortness of the mesentery renders it impossible to perform the necessary manipulations through the wound in the groin.



—**Sequelæ of Strangulated Hernia** —(1) **Artificial Anus** may arise from the sloughing of the intestine and overlying skin apart from operation, or from the surgeon's interference, either by his opening the gut in mistake for the sac, or by his incising it when gangrenous, or it may slough subsequently, if left *in situ* when gangrene is threatening. After a time the surrounding parts settle down and heal over the diversion of the fæces from their natural course becoming more and more complete owing to the formation of what is known as a *spur* of mucous membrane which lies across and blocks the entrance to the lower portion of the bowel. This spur arises partly as a result of the kinking of the gut, partly from the intra abdominal pressure, which pushes the exposed inner wall of the intestine forwards. The effects produced by an artificial anus on the individual vary with the portion of the bowel involved. If the jejunum or upper part of the ileum is thus opened, the patient soon loses ground and becomes emaciated, owing to the escape of the intestinal contents before the nutritive elements of the food have been absorbed. Eczema of the skin in the neighbourhood is usually produced, resulting from the irritation of the fæces. For treatment, see p. 1025.

(2) **Fæcal Fistula** occasionally results from a strangulated hernia, owing to a perforative inflammation of the gut after the relief of strangulation, whether at the site of constriction or above or below it in the latter case arising from a stercoral ulcer. Though the lesion may be intra-peritoneal, it by no means follows that general peritonitis need result, since sufficient plastic material may be formed around it to shut off the general peritoneal cavity, and to allow the extravasated contents of the bowel to find their way outwards through a sinuous tract to the external wound. It may be some days before any evidence of the existence of this condition appears. Not uncommonly the opening will close naturally as a result of cicatricial contraction, and hence no steps need be taken to deal with it until all hopes of such a result have faded. Where however, it persists, attempts may be made to effect this purpose by injecting stimulating lotions, or by applying the actual cautery to the interior of the fistula, but more frequently an operation to expose, if practicable, the wound in the gut, and to close it by suture, or to remove the affected segment, will be necessary.

(3) **Stenosis** of the gut at the site of strangulation may ensue, giving rise to the symptoms already indicated (p. 1014), which may appear weeks or months later.

## CHAPTER XXXVI

### INTESTINAL OBSTRUCTION

By **Intestinal Obstruction**,\* or **Ileus**, is meant a condition in which the onward passage of fæces is prevented. It is often associated with vascular phenomena due to strangulation or kinking of the gut, which result in a deficient supply of arterial blood reaching the part, thereby predisposing to gangrene.

Various elements enter into the picture provided by a classical case of obstruction, and of these the most marked are

1 **Coprostasis**, or retention of fæces. The fact that simple constipation may last for a week or more at a time and do no harm to the patient beyond a certain slight degree of toxic poisoning demonstrates that this is not the only element in cases of obstruction, and indeed is often an almost insignificant factor in acute cases. Yet it colours the whole picture, and has very marked results in the clinical manifestations. Retention of the intestinal contents is certain to be followed by their decomposition and liquefaction, and this causes the intestinal canal to be filled with a quantity of fluid offensive material, partly due to bacterial activity, partly to the pouring out of a considerable quantity of secretion from the congested gut wall. If the obstruction is only partial, this liquefaction of the bowel contents may enable them to pass on, and the patient's attack of partial obstruction is followed by one of diarrhœa, whereby relief is obtained. If the obstruction, however, is complete, the intestine above the block is gradually filled with this decomposing material, from which toxins may be absorbed, the patient being thereby poisoned.

A second result of this decomposition of the retained fæces is the development of gas, which may be so marked as to lead to great abdominal distension or *meteorism*. Whilst present in almost every case to a certain degree, it is most marked when there is considerable involvement of the mesentery, and experiments on animals indicate that constriction of the veins contained therein is the chief factor in its production.

\* For much of the material incorporated in this chapter we beg to acknowledge our indebtedness to Sir Frederick Treves' classical text-book on the subject (published by Cassell and Co.) than which nothing better has appeared, and which we have freely utilized.

2 **Increased peristalsis**, with the object of driving on the intestinal contents past the block, is often an important feature in the case, leading to severe pain of a colicky character. So violent may these efforts become that the bowel, weakened by distension and inflammation, is finally torn, and perforative peritonitis rapidly ends the case.

3 **Regurgitant vomiting** is always a prominent element. At first the gastric contents alone are ejected, but later the vomit becomes bilious, and even stercoraceous or faecal. The origin of this phenomenon is still a little dubious. Some have considered it due to anti-peristalsis, others maintain that the ordinary onward movements of the bowel are quite sufficient to explain it. The intestinal contents are urged forwards against the face of the obstruction, and, being unable to pass, an axial regurgitant stream is produced. It is a little difficult to see how this could occur when the lower end of the colon is the part affected. Whatever the mechanical explanation, there is no question as to the influence of the nervous system in its production, or as to its being chiefly reflex in character, which is evident from the fact that it occurs equally when omentum or bowel is strangled. Hence, it is easy to understand that it commences early in children and sensitive women, on account of the greater irritability of their nervous centres, whilst it is also more marked when the small intestine is involved. Anything that increases peristalsis naturally intensifies its occurrence.

4 **Nervous phenomena** also add their peculiar features to the picture. The affected coil of bowel is directly paralyzed by the lesion, but, in addition, various reflex manifestations occur. Thus, in acute cases the patient suffers almost at once from shock, which passes off after a time, and from paralysis of the gut above and below the site of obstruction, vomiting and perhaps hiccough develop reflexly, and the latter sign is always to be looked on with grave suspicion and as an omen of grave import.

5 **Infective phenomena** are likely to follow sooner or later, the bowel walls being attacked by the virulent organisms contained within them. Complete paralysis and want of blood-supply predispose them to bacterial invasion, and hence the more acute forms of infective gangrene are chiefly seen in conditions of the strangulation type, when mere obstruction is present without vascular changes, microbic invasion rarely produces more than a patchy necrosis, or, more commonly, perforative ulceration. Of course, when infective gangrene is present, virulent toxins develop in the walls of the gut, and a rapid depreciation of the patient's general condition follows from their absorption.

6 Finally, **death** is almost certain to ensue apart from surgical assistance, although a few cases may recover spontaneously. The final event is due either to perforative peritonitis, or to simple exhaustion, the result of toxic absorption from the retained faeces or from the necrotic intestinal wall, of constant pain and vomiting, want of nutrition, and general dehydration of the tissues.

**Causes**—Much elaborate work has been undertaken to produce a

satisfactory classification of the many diverse causes of intestinal obstruction, and when one mentions the fact that a recent attempt included eighty distinct causative lesions, it is obvious that there is an abundant field for this type of ingenuity. It must suffice here to state that there are two great divisions—the dynamic and the mechanical.

(1) Dynamic ileus is due to some paralytic or spasmodic condition of the intestinal wall, which results in interference with its power of transmitting onwards its contents. *Paralysis* of the bowel results from (a) Diffuse or localized acute infective inflammation, as in septic peritonitis or acute appendicitis, (b) torsion of intra-abdominal viscera, such as the spleen or omentum, or of tumours, *e.g.*, ovarian cysts, leading to the so-called ‘aseptic’ peritonitis, (c) embolus or thrombosis of the mesenteric vessels, leading to necrosis, (d) nervous lesions, which may involve the spinal cord itself, or more frequently the peripheral nerves, *e.g.*, a tumour at the root of the mesentery. *Spasm* of the gut, as by chronic lead-poisoning, may also determine obstructive phenomena.

(2) Mechanical ileus is the variety most commonly seen. (a) The gut may be *strangled* by bands or through apertures, causing internal strangulation. (b) It may be *kinked* over bands, thereby determining not only occlusion of the lumen, but also a marked interference with the vascular supply. (c) The gut may be *twisted* on its own axis, giving rise to a condition known as *volvulus*. (d) One portion of the bowel may be *invaginated* into a neighbouring portion, constituting an intussusception. (e) The lumen of the bowel may be *blocked* by foreign bodies or accumulations of *fæces* (obturation). (f) The onward passage of the *fæces* may be rendered difficult or impossible by the gut becoming *narrowed*, as from cicatricial or cancerous stenosis, or the pressure of external tumours.

The most useful division is, however, the clinical, grouping together those cases which present a similarity in the symptoms, and this method will be employed here, the subject being discussed under the three headings—acute obstruction, chronic obstruction, and intussusception.

### Acute Intestinal Obstruction

The following are the chief **Causes** which give rise to this condition

- 1 Strangulation by bands or adhesions, or through apertures, etc
- 2 Volvulus
- 3 The impaction of foreign bodies
- 4 Strangulation over a band or acute kinking of the gut, both very rare conditions
- 5 Acute intussusception
- 6 It may be the termination of a chronic obstruction
- 7 Acute localized paralysis of the gut due to an infective inflammation, *e.g.*, acute suppurative appendicitis

It will be noted that in the first five of these causes, where the ileus is primary, there is a definite vascular lesion in addition to the obstruction, which threatens the patient at an early date with per-

forative ulceration or gangrene, and it is mainly on the presence of this element that the acuteness of the symptoms depends

The **General Symptoms** of acute obstruction are practically identical with those of a strangulated hernia. The patient is suddenly seized with severe abdominal pain somewhat of the nature of colic, and perhaps referred to the umbilicus, coming on sometimes during some special effort, e.g., lifting a heavy weight, or sometimes when lying quietly in bed. At the same time he suffers from shock, as evidenced by a weak pulse, pale face, and cold, clammy sweat, the temperature of the body falling below the normal. The shock is usually more or



FIG. 407.—STRANGULATION OF A COIL OF THE LOWER END OF THE ILEUM BY A BAND DEVELOPED IN THE NEIGHBOURHOOD OF THE VERMIFORM APPENDIX (KING'S COLLEGE HOSPITAL MUSEUM)

less recovered from, but the pain persists, and is liable to exacerbation and intermissions, soon becoming continuous. Vomiting ensues, being at first limited to the contents of the stomach, but quickly changes to a bilious, stercoraceous, or even faecal character. Distension of the abdomen is usually present, but its amount and characters vary with the site of the lesion. Signs of constitutional depression and exhaustion follow in a short time, the pulse becoming weak, rapid, and thready, the temperature remaining subnormal (except occasionally after the supervention of peritonitis, when it may rise a few degrees), the face looking pulled and drawn (facies Hippocratica), and the abdomen being distended and painful. Finally the patient, if unrelieved by treatment, dies, and usually within seven to ten days from the onset, owing to exhaustion or perforative peritonitis. Constipation may be absolute from the first, not even flatus

being passed, but at any time the lower bowel may empty itself, and raise false hopes as to the prognosis

**The Special Forms of Acute Obstruction** must now be considered *seriatim*

1 **Strangulation by Bands or Adhesions through Apertures, etc** Causes *(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100)* are usually the result of old plastic peritonitis of a localized and chronic character. The greatest variety is met with in the appearance and situation of these adhesions, most frequently they are single and cordlike, sometimes they are broad and membranous, constituting a false ligament, or, again, they may be multiple. A common situation is between different parts of the mesentery, or between the mesentery and some other viscus, the cause being either disease of that viscus (usually a pelvic organ, the cæcum, or the appendix), or inflammation of a mesenteric gland with localized peritonitis. Two methods of producing strangulation exist, either the bowel passes under the arch or loop formed by a short constricting band, and cannot return (Fig 407), or, if the band is long, it may form a loop or noose through which the bowel passes, and so becomes strangled (Fig 408)

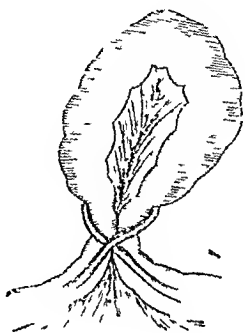


FIG 408—STRANGULATION BY BAND (TILLMANN'S)

(b) *Cords formed by the omentum* result from union between its fimbriated extremities and some part of the viscera or parietes, forming at first a broad band-like adhesion, which is gradually moulded into a rounded cord by the constant dragging and pulling to which it is subjected. They are usually coarser and thicker than those due to peritonitis. The mechanism of strangulation is identical, the noose form being perhaps the more common, since the adhesions are likely to be longer. (c) *Meckel's diverticulum* (p 1006) is liable to cause strangulation when its free end becomes adherent either to the parietes or to the viscera, and after that to the neighbourhood of the umbilicus. Occasionally the diverticulum ends in a fibrous cord, which may remain fixed to the umbilicus, or floats free in the abdominal cavity, and subsequently becomes adherent to some other structure, thus producing a fibrous cord. Strangulation may be effected by bowel passing under the loop formed by the adherent diverticulum. (d) The *vermiform appendix*, *appendices epiploicæ*, or *Fallopian tubes* may contract abnormal attachments, and thus form arches or loops under which bowel may pass and become strangled. (e) *Slits, pouches, and apertures* in the peritoneal investment, whether normal or abnormal, may lead to strangulation. All external herniæ may be grouped under this heading, as also those rare conditions known as internal hernia, in which the abdominal contents find their way into pouches in the posterior wall of the peritoneum, e.g., into the lesser sac of the omentum, or the so-called fossa duodeno-jejunalis. Slits may also be found in the

omentum or mesentery, either congenital, traumatic, or the result of operations

**Phenomena**—This form of obstruction usually occurs in young people, and is rare after forty, it constitutes above one-fourth of all the forms of internal obstruction, and the lower 2 feet of the ileum are most frequently involved. There is commonly a previous history of peritonitis, but the onset is usually sudden, and the symptoms of strangulation, as detailed above, are of a typical character. The abdomen is flaccid at first, and not tender until peritonitis ensues, on about the third or fourth day. There is generally no obvious tumour, and no peristalsis or dilated coils of intestine are to be seen. Occasionally an area of localized fulness or fixed and limited tenderness may indicate the site of the lesion. The average duration is about five to seven days, the patients dying of exhaustion or toxæmia following peritonitis.

2 **Volvulus** is the most common cause of acute primary obstruction of the large intestine. By it is meant a rotation of the gut upon its own mesenteric axis in such a way as to interfere not only with the passage of the intestinal contents, but also, sooner or later, with the circulation, determining a condition of strangulation. Occasionally a similar result is brought about by the intertwining of one coil, usually of small intestine, with another. The sigmoid flexure is the part mainly affected, although it occurs in the cæcum or small intestine. In the former situation it is predisposed to by a long narrow sigmoid meso colon, so that the two ends of the loop are brought closely together, this condition may be of congenital origin, but is usually due to the traction induced by prolonged chronic constipation, a distended sigmoid hanging into the pelvic cavity drags upon and elongates the meso-colon, tending to approximate the two ends of the loop, and necessarily causing a slight obstruction at these spots. Some irregular movement of the gut or of the abdominal walls suffices to cause rotation of the pedicle, and thus brings about the volvulus. When once present, plastic peritonitis soon fixes the coil, whilst the pressure on the vessels causes venous congestion and such obstruction to the arterial supply of the gut as almost certainly to end in its death. Distension of the coil with gas from decomposition of the retained fæces also aggravates the condition.

**Symptoms**—Volvulus is rare before the age of forty, and apparently occurs more often in the male sex. A history of chronic constipation precedes it, but the acute symptoms start abruptly. Pain is always present, at first intermittent, but finally constant, and there is usually early tenderness over the sigmoid flexure. The pain, vomiting and collapse are not so severe or marked as in other forms of strangulation, but abdominal distension from excessive flatus, and resulting dyspnœa and thoracic embarrassment, are very distressing. Tenesmus is occasionally present. A localized peritonitis is usually developed, but sometimes it becomes diffuse. Natural-cure-is-unknown, the patient dying either in five or six days from collapse and interference with respiration, or at a somewhat later date from peritonitis.

3 **Impacted Foreign Bodies**, which may cause intestinal obstruction, are of three types gallstones, foreign bodies that have been swallowed, or intestinal concretions (enteroliths) The general facts connected with their presence in the intestine have been already noted (p 1010)

Gallstones only cause obstruction when of large size, and then usually gain entrance to the intestine by ulceration from the gall-bladder into the duodenum The usual site of impaction is in the lower ileum Women over fifty are most often the subjects of this condition, and there may be merely a history of some inflammatory lesion in the region of the gall-bladder, and none of biliary colic Such patients frequently suffer from intermittent subacute attacks of incomplete obstruction, which, though severe for a time, are relieved by purgatives If the gallstone is not passed, a final acute attack supervenes, which begins suddenly with pain and slight collapse, followed by vomiting, which is constant and copious, and in twenty-four to thirty-six hours becomes fæcal The obstruction is often incomplete, flatus and even fæces being occasionally passed The abdomen is soft and flaccid, and the affected coil and the gallstone are rarely to be felt Necessarily the symptoms vary with the site of impaction, usually becoming more urgent as the duodenum is approached Death results from peritonitis or exhaustion

Similarly, enteroliths are usually impacted near the cæcum, and if causing acute obstruction the symptoms are similar to those produced by a large gallstone, being preceded by chronic attacks and severe colicky pain In thin persons their presence may be detected by palpation of the abdomen

4 Acute obstruction ensues when a coil of intestine lodges across a tightly-drawn adhesion, the lumen at each end being thereby entirely occluded, and the circulation arrested The usual acute symptoms follow, which may, however, be relieved spontaneously Sudden kinking of the gut may lead to the same result, being due to the contraction of fibrous adhesions or the dragging of diverticula

5 For **Acute Intussusception**, see p 1114

6 When acute symptoms are developed at the termination of a case of chronic obstruction, the pain from being intermittent becomes constant, the vomiting more violent and fæcal in character, and the fatal termination is due to acute peritonitis, or to exhaustion and toxæmia Absolute constipation is always present, and the abdomen is much distended

7 True obstruction is sometimes associated with acute localized enteritis or peritonitis, such as is seen in appendicitis, when the intestinal walls are paralyzed This symptom is sometimes very marked, and even fæcal vomiting may occur, but by careful attention to the history and general condition of the patient a correct diagnosis should be reached We append a table illustrating the chief diagnostic points between acute strangulation and acute appendicitis associated with peritonitis, one of the commonest causes of dynamic ileus



	ACUTE INTERNAL STRANGULATION	ACUTE APPENDICITIS WITH PERITONITIS
Onset -	Abrupt	May be preceded by local pain
Rigor -	Absent	Often present
Temperature	Subnormal at first, rising at onset of peritonitis	High at first, falling later from exhaustion or toxæmia
Pain -	Severe referred to the umbilicus	Severe, usually referred to the right iliac fossa
Tenderness	Absent till peritonitis comes on	Present over cæcum even in early stages, and gradually spreading
Vomiting	Early marked, and soon fecal	Less urgent, and seldom fecal, except as a late symptom
Abdominal parietes	Flaccid till peritonitis is present	Tense and rigid from the first

In most forms of dynamic ileus the obstructive phenomena are usually secondary to some peritonic trouble, or to some intra-abdominal lesion which produces its own symptoms first, and then obstructive phenomena only as a secondary result of inflammatory paralysis. Thus in torsion of the pedicle of an ovarian cyst, the patient first complains of pain, and the tumour becomes large and tender. Should it be neglected, aseptic peritonitis ensues after a variable period, intestinal paralysis follows, and obstructive symptoms of a distressing type are produced, which will probably prove fatal, even if the cause is removed.

The diagnosis and method of examination of acute obstruction are dealt with at the end of the chapter (p 1116)

The **Treatment** of acute obstruction is practically included in one word—**Laparotomy**. The condition of the gut is in most cases identical with that found in a strangulated hernia, and although a few patients may recover by palliative measures, *e.g.*, enemata, opium, ice, etc., yet the majority would be gravely injured in the delay caused by their employment. The danger of laparotomy increases directly with delay, hence, the sooner it is undertaken, the better for the patient. Whilst preparations for the operation are being made, an enema may be administered to clear the lower bowel, ice being given to suck, and a small dose of opium to relieve urgent pain. Two main objects must always be kept in mind in the operative treatment of such cases, *viz.*, (*a*) to empty the distended bowel, and (*b*) to remove the cause of the obstruction. The second of these requisites is always most desirable, but unless at the same time the putrid contents of the upper portion of the intestine are removed, little real good has been accomplished, since the patient is being slowly poisoned by septic absorption. The late Mr Greig Smith has declared most emphatically that 'no operation for intestinal obstruction is complete if the patient leaves the operating-table with a greatly distended abdomen'. Moreover, it must be remembered that the formation of an artificial anus is often insufficient to give

relief, owing to the paralyzed and distended condition of the intestinal wall above. Hence, in many cases it is desirable to deal with the engorged bowel first, and to leave the search for the obstructing body till a later date. A very high death rate must always be expected in these cases, but statistics prove that, in cases where the cause of the obstruction is not at once obvious, primary enterostomy, if followed by a satisfactory discharge of the intestinal contents, gives results in many instances equal to, or even better than, treatment directed towards the cause of the trouble.

In the *most urgent cases*, where the patient's abdomen is acutely distended, and fæcal vomiting has been present for some time, it is not advisable to administer a general anæsthetic. If such is attempted, the patient's life is often lost from stoppage of the respiration, precipitated possibly by a severe attack of fæcal vomiting. A few drops of cocaine may be placed under the skin, and a small incision made through the linea alba below the umbilicus, the first presenting coil of intestine is withdrawn, and after protecting the peritoneal cavity with gauze or sponges is tapped with a large trocar and cannula so as to allow the first gush of flatus and fæces to be carried away from the wound. The opening is then enlarged sufficiently to allow a Paul's tube to be introduced and tied in, and whilst the bowel is emptying itself, it is fixed by stitches to the abdominal wall. The stomach should always be thoroughly washed out with warm water before or during the operation.

In *less severe cases*, the stomach should be washed out as a preliminary measure before administering the anæsthetic. The head should not be placed on a lower level than the stomach, for fear of fluid regurgitating along the œsophagus and choking the patient, several deaths from this cause have been reported. The abdomen is then opened in the middle line below the umbilicus, and a definite search made for the cause of the obstruction if it is not at once obvious. The hand is first passed to the hernial regions, and then to the right iliac fossa, so that the cæcum may be examined. If this is distended, the cause necessarily lies below it, if collapsed, above it. In the former case, the condition of the sigmoid flexure should next be investigated, and finally, if this viscus is collapsed, the hand should be run along the colon, special attention being directed to the splenic flexure. If the cæcum is collapsed, perhaps the best method to adopt is to gently withdraw from the abdomen successive portions of gut, about a foot at a time. These are carefully examined, and replaced by the assistant whilst the next portion is being withdrawn. The remainder of the intestines during this process are protected and kept back by the application of hot sterilized abdominal cloths. The cause of the obstruction is in this way sooner or later discovered, and may be dealt with according to circumstances. If the intestines are too distended to allow of such manipulation, it may be advisable to open or tap one or more of the dilated coils, and thus reduce the distension before proceeding with any methodical search for the obstruction.

Omental bands or peritoneal adhesions should be divided between

ligatures The vermiform appendix or Meckel's diverticulum may be excised according to the method described at p 1043 A volvulus should be untwisted, if possible, but this is usually impracticable, owing to peritoneal adhesions, and in such cases it is advisable to withdraw the coil from the abdomen, and if the large intestine is involved, an artificial anus should be made Foreign bodies are, if possible, displaced forwards or backwards to a more healthy portion of the bowel, and then removed by a longitudinal incision along the anti-mesenteric border, the wound being subsequently closed by a row of Lembert's sutures Of course, volvulus of the small intestine or gangrene of the gut, if present, may necessitate an enterectomy, but it must always be kept in view that the essential feature of the operation is drainage of the intestine, and therefore the establishment of an artificial anus as a temporary measure is often desirable, re-union can be effected when the gut has emptied itself

### Chronic Intestinal Obstruction

The Causes of chronic obstruction are very numerous, and, looked at from an anatomical standpoint, may be divided into the following groups

1 Intra-intestinal conditions, *e g*, impaction of fæces, foreign bodies, etc

2 Affections of the intestinal wall, such as stricture, new growths, especially those of a cancerous type, adhesions or matting together of coils of intestine, contraction or kinking of the gut from mesenteric gland disease, etc

3 Compression of the bowel by tumour, cicatricial bands, etc, developing outside the intestine

Fæcal impaction and the development of a cancerous growth are far and away the commonest causes of chronic obstruction

The General Symptoms of chronic obstruction are more or less as follows The patient suffers from gradually increasing constipation, alternating occasionally with watery diarrhœa, spurious in nature, and set up partly by a catarrhal enteritis due to the irritation of retained fæces, partly by decomposition of the fæcal material At irregular intervals more severe symptoms arise, consisting of pain, colic, vomiting, and absolute constipation, owing to some temporary complete obstruction, as by the impaction of a mass of undigested food or fæces, assisted perhaps by a valve-like fold of mucous membrane across the passage The abdomen becomes distended, and coils of gut may be seen in a condition of active peristalsis These attacks usually pass off after a time, a copious evacuation or the bowels taking place, either naturally or after the administration of a purgative Finally, one of these seizures persists and destroys the patient, either by exhaustion or perforation followed by peritonitis, unless suitable treatment is promptly adopted The vomiting is never such a marked feature as in acute obstruction, until the final stage, when it becomes fæcal The abdomen is always more or less

distended and tympanitic, and its contour varies with the site of the obstruction, if this is situated above the ileo cæcal valve, the swelling is mainly central, whilst if in the rectum or lower portion of the colon, it is most marked in the flanks. Distended coils of intestine can be plainly seen through the abdominal walls in thin subjects, as also evident peristalsis. When arising from simple stricture, no tumour is to be felt, but if due to malignant disease, and if the abdomen is not very distended, the growth may possibly be detected.

**Fæcal Impaction** occurs in adult females who have previously suffered from chronic constipation.

The cæcum and sigmoid flexure are the most common seats of obstruction, but the transverse colon is not unfrequently affected (Fig. 409). A doughy tumour may often be felt at one of these spots, which can in some cases be indented with the fingers, whilst in others it may be of stony hardness. The surface of the mass is usually more or less nodulated, and the intestine tender from the accompanying inflammation. The temperature is often raised, from toxic absorption through the intestinal wall, and there may even be a rigor. The acute symptoms are always preceded by a prolonged period of malaise and ill-health, the appetite

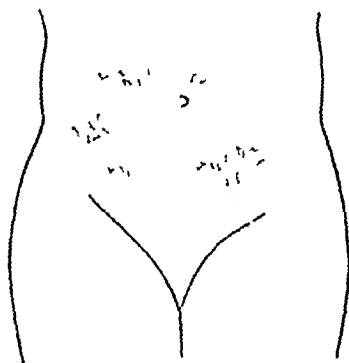


FIG. 409.—DIAGRAM TO INDICATE THE USUAL SITES OF FÆCAL IMPACTION—VIZ., THE CÆCUM, TRANSVERSE COLON, AND SIGMOID.

being defective, the breath offensive, and the tongue foul. On rectal examination the presence of scybala may often be detected.

The special symptoms arising from the other conditions which give rise to chronic obstruction, such as stenosis of the bowel, have been already referred to (p. 1013).

The **Diagnosis** of chronic obstruction is obvious, but it is often by no means easy to ascertain the exact cause of the trouble. A thorough investigation of the case, according to the plan given hereafter, must be undertaken, and by this means some conclusion may be arrived at as to the nature and seat of the obstruction.

The **Treatment** of chronic obstruction is always a matter of difficulty and anxiety, owing to the uncertainty often felt as to the diagnosis. It ought to be possible, however, to decide whether the block is located in the large or small intestine, since the character of the abdominal distension and the symptoms are tolerably distinctive in the two forms.

If the case is not of the most urgent type, the patient is put to bed, the diet restricted to fluids, and belladonna, combined with small doses of calomel, administered. At the same time copious enemata should be given two or three times daily, and preferably in the genu-pectoral position, or lying on the right side with the pelvis well raised. Purgatives are studiously avoided, as also opium, probably

the patient has taken plenty of the former before coming under observation, whilst the latter, although it may check vomiting and relieve pain, is certain to mask symptoms, and thus prevent the true course of the disease from being watched. Should the symptoms be urgent from the commencement, or the treatment suggested fail, the question of operation has to be faced. If the obstruction is located in the small intestine, a laparotomy must be undertaken, using the same precautions as in acute cases. If the cause of the trouble is easily found, a coil situated just above is withdrawn from the abdomen, opened, and a Paul's tube subsequently tied in so as to allow retained faecal material to escape. It is wiser not to deal with the local trouble (unless strangulation is present) until the urgent symptoms have disappeared. If, however, the patient's condition is serious and the site of obstruction cannot be readily found, any distended coil may be withdrawn and opened. The practice of allowing numerous coils of intestine to escape in order to facilitate the exploration of the abdomen is not to be recommended.

When the cause of the obstruction is located in the large intestine, colotomy is usually required. The lumbar operation may possibly be undertaken, but the majority of surgeons at the present time prefer the iliac proceeding, although the peritoneum has to be opened, and the risk of faecal contamination is thus increased. If the rectum or sigmoid flexure is clearly the seat of the trouble, the usual incision on the left side can be made, but if there is no indication as to the part of the colon involved, a median laparotomy is perhaps preferable, a distended portion of the gut being withdrawn and tapped, and a Paul's tube tied in.

In chronic peritonitis, where the intestines are hopelessly matted together, but little can be done beyond the administration of enemata, and possibly abdominal massage. The history of the case will generally suffice to suggest its nature, and operative treatment should then be avoided.

Faecal impaction requires the regular and repeated administration of large enemata, given through a long tube, whilst belladonna and calomel may also be administered. Should hard scybala be lodged in the rectum, it may be necessary to break them up *in situ*, and remove them piecemeal.

### Intussusception

By Intussusception is meant the protrusion or invagination of one part of the intestine into another, giving rise to the condition illustrated in Fig 410. The constituent parts are seen more diagrammatically in Fig 411. The upper portion is always prolapsed into the lower, except occasionally during the irregular peristalsis which takes place during the death-throes. The invaginated portion (a) is known as the intussusceptum, whilst the lower portion (b) into which it is protruded is known as the intussusciens. An intussusception, then, consists of three layers—the outer or ensheathing layer (1), an

inner or *entering* layer (iii), and between the two the *returning* layer (ii). Not only does the intestine enter, but with it a certain portion of the mesentery; and it is to the constriction of the vessels contained therein, and later on possibly to their complete obstruction, that the more serious phenomena are due, *e.g.*, gangrene, perforation, or rupture of the gut. In

addition to this, actual obstruction to the passage of the intestinal contents may be brought about by the traction of the mesentery, which renders the orifice of the intussusceptum slit like, by the swelling and congestion of the intestinal wall, or perhaps by the impaction of a portion of undigested food within the lumen of the gut. Peritonitis usually follows, being possibly due to the invasion of a portion of the damaged intestinal wall by the *B. coli* or other intestinal organisms. If limited in extent, it may merely lead to irreducibility of the intussusception, owing to adhesions forming between the serous coats of the entering and



FIG. 110.—INTUSSUSCEPTION (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM)

returning layers. In other cases, and especially when ulceration or gangrene is present, a diffuse peritonitis may be lighted up, and this may result in the death of the patient. The bowel above the site of invagination becomes dilated, and possibly stercoral ulcers may be formed, particularly in the more chronic cases.

The Cause of intussusception is generally stated to be irregular and violent peristalsis, however induced, whether by the presence of irritating ingesta, or by the existence of polypoid tumours, malignant growths, or possibly worms, the presence of scybalous masses of fæces may also lead to its occurrence. In a few cases injury, *e.g.*, blows on the abdomen, or severe strains during jumping, have been held responsible for its onset.

Intussusception is met with in four chief situations. (1) The ileo-cæcal variety is much the commonest, constituting 44 per cent of all cases (Treves). In it the ileum is protruded into the colon, the apex of the intussusceptum being formed by the ileo-cæcal valve. Owing to the great mobility of the ileum, a considerable portion of gut may be thus invaginated, and a good many cases have been observed in which it has actually projected through the anus. (2) The *enteric*

variety involving the small intestine comes next in order of frequency, being met with in 30 per cent of the cases. It is most often seen in the lower jejunum, and is rarely of great size. (3) The *colic* form may occur at any part of the colon or rectum, and, owing to the fixity of this portion of the gut, is limited in extent. It is met with in about 18 per cent of the cases. (4) The *ileo colic* only occurs in 8 per cent, in it the ileum is protruded through the ileo-cæcal valve, which for a time retains its normal position, but after the intussusception has attained a certain size, the valve and cæcum are also invaginated into the ascending colon. In each of these varieties, except the last, the intussusception grows at the expense of the external or ensheathing layer, the apex of the protrusion being always formed by the same portion of gut, but in the ileo-colic variety, as just stated, it increases by the passage of more and more of the ileum through the valve, after a time this stops, and is replaced by the ordinary form of growth.

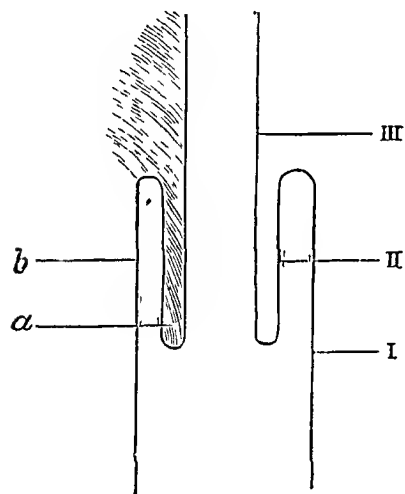


FIG 411 — DIAGRAM OF INTUSSUSCEPTION

a, Intussusceptum b intussusciens I, ensheathing layer, II, returning layer III, entering layer

Intussusception is occasionally met with as a *post-mortem* phenomenon, due to the irregular intestinal movements occurring during the death crisis. The condition is recognised as being of this nature by the absence of inflammatory signs, by the fact that it is sometimes due to a reverse peristalsis, and by more than one intussusception being present.

The **Clinical History** varies according to whether the condition is acute or chronic.

**Acute Intussusception** occurs most frequently in young children, the onset being usually sudden. The

child is attacked with severe pain, possibly localized and more or less paroxysmal at first, but rapidly becoming continuous and diffused over the abdomen. This is followed by vomiting, which, however, is less severe than in acute strangulation, and not so often feculent. The patient rarely suffers from absolute constipation, diarrhoea and the discharge of blood-stained mucus, perhaps associated with tenesmus, being common. Collapse soon supervenes, and in the worst cases this may be so severe as to kill the patient within twenty-four hours, otherwise a fatal issue from exhaustion or peritonitis is reached within a week. On examining the abdomen, but little distension or tenderness is noted, unless acute peritonitis is present, in about half the cases a distinct tumour can be felt, cylindrical in outline, and sometimes described

as 'sausage-shaped,' following the course of the intussusception and generally curved, owing to the traction of the mesentery. In the ileo caecal variety it extends from the right iliac fossa across the brim of the pelvis to the left, the colon being dragged downwards. This may be associated with an absence of resistance in the right fossa, which feels empty, constituting what is known as the 'signe de Dance'. In other cases the tumour may be more limited, and distinctly moveable.

A natural cure occasionally follows, resulting either from spontaneous reduction, or from sloughing of the intussusceptum, whilst the peritoneal cavity is shut off by a circle of plastic lymph uniting the ensheathing and entering layers of the gut. When the latter takes place, the subsequent condition is not very satisfactory, owing to the formation of a fibrous stricture.

**Chronic Intussusception** occurs more frequently in adults than in children, the onset being gradual and the course varying widely in different cases. The patient complains of intermittent attacks of pain of a colicky nature, which recur at intervals, the attacks becoming more frequent and prolonged as the case progresses. Vomiting is often but little marked during the intermissions. The bowels are irregular in their action, and there is sometimes a blood-stained mucous discharge. The general condition is not at first much affected, but as the case progresses, emaciation and general asthenia may supervene. On examination, the abdomen is found to be flaccid and free from tenderness, although visible coils of intestine may be observed in some cases, and perhaps a tumour felt. The symptoms are rather those of subacute enteritis and chronic obstruction than of strangulation, and the case may be brought to a fatal termination either by an acute attack of obstruction or by peritonitis. It may, however, last a long time before being recognised.

**Treatment**—In the most acute forms of the disease but little can be done, owing to the extreme prostration of the patient, but in the less severe and in the chronic cases much can be attempted to prevent a fatal issue.

In acute intussusception the patient should be at once placed under the influence of opium, in order to still peristalsis and prevent the increase of the tumour. Inflation of the bowel with air, or the injection of copious enemata of warm water or oil, may then be carefully undertaken. No undue force should be employed in this proceeding, and a hand placed over the tumour may enable the surgeon to detect whether or not it has been successful. It is performed by raising the patient's pelvis and inserting into the rectum a catheter, with which is connected an indiarubber tube and funnel, held about 1½ or 2 feet above the abdomen. Should this not succeed, laparotomy should be performed without delay, and the condition of the intussusception investigated. An attempt is then made to reduce it by grasping the tumour in one hand and gently trying to peel off the ensheathing layer from the upper portion of bowel, which is steadied by the other hand. In about half the cases reduction is impracticable, owing to



the presence of adhesions, and if the general condition of the patient is fairly good, the intussusception should be removed and the divided ends of the bowel united by suture. If, however, the patient is in a condition of profound shock, all that can be done is to fix the bowel in the wound, and make an artificial anus. The results of these procedures are anything but encouraging, for F. H. Wiggan has shown that few children recover if anything more than simple reduction is required during a laparotomy.

Chronic intussusception is more favourable in its prognosis. It is frequently unrecognised until an exploration of the abdomen is made, and hence reduction by inflation is not commonly attempted. In some cases the tumour may be reduced by simple manipulation, but as a rule too many adhesions are present. Excision of the mass should then be undertaken, and the results gained have been very encouraging.

### Diagnosis and Method of Examination of a Case of Intestinal Obstruction

A grave responsibility rests upon the medical attendant in every case of obstruction. The condition is incompatible with life beyond a few days, and the time occupied in observing the patient and making up one's mind as to the nature of the case is valuable time lost, which may ruin the patient's chances of recovery. There are three things to be avoided in conducting a case of this nature: (i) Purgatives — The patient has probably taken plenty before sending for assistance, and the only result to be expected is an increase of pain and vomiting; (ii) Opium has its place in the treatment of obstruction, viz., in relieving the agony associated with its onset, but beyond this it merely masks symptoms, and can do no good but comfortably to conduct the patient to the graveside. It causes intestinal paralysis, and therefore may check the most distressing symptom, vomiting, but it aggravates the condition which needs treatment; (iii) Delay in sending for surgical assistance is responsible for more deaths than is the condition itself. When once the gut has become generally paralyzed, there is but little hope for the patient.

In the investigation of a case various problems of some difficulty have to be solved, and it is well to undertake this task methodically.

1 The medical attendant must satisfy himself that obstruction is present, and not merely aggravated constipation. In the latter, however, flatus passes readily, and the general condition is not much impaired. In obstruction there is usually a complete arrest of flatus, and abdominal pain and vomiting often point to the existence of some serious lesion.

2 It is essential to ascertain whether the obstruction is dynamic or mechanical. The differences and distinctions between these have been already alluded to (p. 1103).

3 The question as to whether the lesion is acute or chronic must next be settled. The initial severe pain and collapse, the rapid onset

of vomiting, the localized spot of fixed tenderness, and the quick depreciation of the patient, all point to some vascular lesion of the intestinal wall, which will prove fatal in a few days unless suitably treated. On the other hand, chronic cases are often preceded by constipation and other troubles of defecation, they come on gradually, and are at first unaccompanied by constant pain and vomiting, although colic of a severe type may be present. The examination of the abdomen is also of the greatest assistance, in acute cases intestinal paralysis dominates the picture, in chronic cases, vigorous peristalsis can be felt and often seen unless the patient has been left too long.

4 An effort must be made to determine the *site and nature* of the lesion. As to the question of site, the following points may be noted \*

(a) When the *upper part of the small intestine* is involved, the vomiting is early, tumultuous, and persistent, the vomit is bilious, but not faecal. Abdominal distension involves the epigastrium, and particularly the stomach. The lower part of the abdomen may be retracted. Collapse is early and rapidly increases. The thirst is terrible, the urinary secretion slight or even suppressed, gas and faeces may pass from the lower bowel.

(b) When the *lower part of the small intestine or caecum* is involved, faeces and flatus cannot pass, the vomiting becomes faecal, meteorism is marked, and involves the central part of the abdomen, the flanks not being affected. In chronic cases peristalsis is very evident.

(c) When the *colon or rectum* is the site of obstruction, the symptoms are more chronic as a rule, and even in acute cases, such as volvulus, the initial collapse is slight. Vomiting is later in appearing, but may, of course, become faecal. Meteorism may be very marked, and involves the flanks as well as the centre, sometimes it is possible to recognise that the lesion is not lower than the splenic flexure by distension of the left flank being absent.

The determination of the *nature* of the case will largely turn on the patient's previous history, and not uncommonly one has to admit that, although one can locate the site of mischief, there is no clue as to its nature beyond the generalizations learnt from statistics.

The actual examination of the patient is carried on along the following lines

1. The Previous History of the case should be carefully gone into, in order to ascertain whether or not the patient has suffered from biliary colic, chronic constipation, acute diffuse or localized peritonitis, uterine derangements, syphilis or dysentery, etc.

2. The History of the Present Attack should then be considered, noting especially the manner of onset, whether acute or gradual, the duration of the symptoms, and whether or not preceding subacute attacks have occurred from time to time.

3. The more prominent **Symptoms** must then be considered.

(a) *Collapse* is due partly to reflex nervous disturbance, partly to the absorption of toxic materials, and partly to withdrawal of fluid

\* See Tavel, *Revue de Chirurgie*, August, etc., 1903

from the body as a result of the vomiting, the portal area is also much engorged, and this adds to the want of fluid in the systemic circulation. The nervous cause is most active in the early stage of acute obstruction, especially in infants, whilst the toxic is largely responsible for the exhaustion seen at the end of an acute attack or in the chronic variety. Hence collapse is early in acute cases, late in chronic. Moreover, the higher the lesion, the greater the shock, owing to the fact that the upper portion of the bowel is more intimately associated with the sympathetic nervous centres.

(b) Pain is a very marked symptom, being usually referred at first to a little above the umbilicus, and is more severe in lesions of the small intestine than in the colon. It varies greatly with the completeness or not of the obstruction. This matter has been especially emphasized by Treves, who has pointed out that when the obstruction is but partial the pain is intermittent, whilst when the block is complete the pain becomes continuous. Hence in acute strangulation pain is almost invariably constant, whereas in stricture it is markedly intermittent and of a colicky nature. The amount of pain, moreover, varies with the nervous excitability of the patient, it is increased by anything which induces peristalsis, e.g., food or purgatives, and it is diminished on the supervention of gangrene.

(c) Abdominal tenderness is rarely observed in the early stages, being caused by the onset of peritonitis.

(d) Vomiting is an almost invariable accompaniment of obstruction. Its cause has been already discussed (p 1102). When the obstruction is situated in the jejunum or upper part of the ileum, the vomiting is never really faecal in character, although, if it has been temporarily checked by opium, the ejecta may be exceedingly offensive and dark in colour, owing to decomposition, true faecal vomiting can only come from an obstruction to the lower ileum or colon.

(e) Constipation, although usually present, is not necessarily absolute, as it is possible for the lower bowel to be emptied in cases of obstruction, whilst the patient sometimes passes a motion as gangrene supervenes or death is approaching.

4. A most careful Physical Examination must now be instituted.

(a) An inspection of the uncovered abdomen should first be made. The amount and character of the distension is observed, and whether or not it is situated in the centre, as when small intestine is involved, or in the flanks when the obstruction is in the rectum or sigmoid flexure. The existence of visible peristalsis or enlarged coils of intestine should be noted, such are rarely seen in the acute cases, but may be very evident in the chronic forms. Sometimes one coil remains persistently distended and always at the same spot, its appearance always suggests that the site of obstruction is not far away. The rise and fall of the abdomen during respiration should be watched to ascertain whether the movements are equal on both sides, or if any prominence, such as would be caused by a tumour, is noticeable. The general condition of the patient, whether

emaciated or not, as also the appearance of the face and the position in which he lies, should be observed

(b) All the normal and abnormal hernial apertures are thoroughly investigated, as also the rectum and vagina

(c) The abdomen is carefully palpated, so as to ascertain the existence of any tumour or increased resistance of the abdominal walls

(d) Percussion may also throw some light on the case

(e) Finally, some information may be gained by the use of cucumata. When the obstruction is low down and not far from the anus, it may be impossible to introduce more than a small quantity of fluid, and this in spite of modifying the position. Too much reliance, however, must not be placed on this sign. It is also desirable to ~~auscultate~~ the colon during the administration of a large enema, it is sometimes possible to hear gurgling sounds as far round as the cæcum, indicating that the large intestine is free from obstruction. We would call attention here to the fallacy of using a long tube in the expectation of being able to pass it into the sigmoid flexure. A careful study of the rectum and its valves will show the difficulty of this, whilst the use of the genu-pectoral position renders it unnecessary.

## CHAPTER XXXVII

### AFFECTIONS OF THE RECTUM AND ANUS

THE rectum from the anatomical standpoint consists of the lowest 4 inches of the intestinal canal, but for the surgeon it represents the lower 6 or 8 inches which can be reached more or less from the anus. *Examination of the rectum* is carried out by the following methods

1 **Digital Examination**, in which the index finger is inserted through the anus. Soap should be smeared under the nail and into the semilunar fold at its base, so

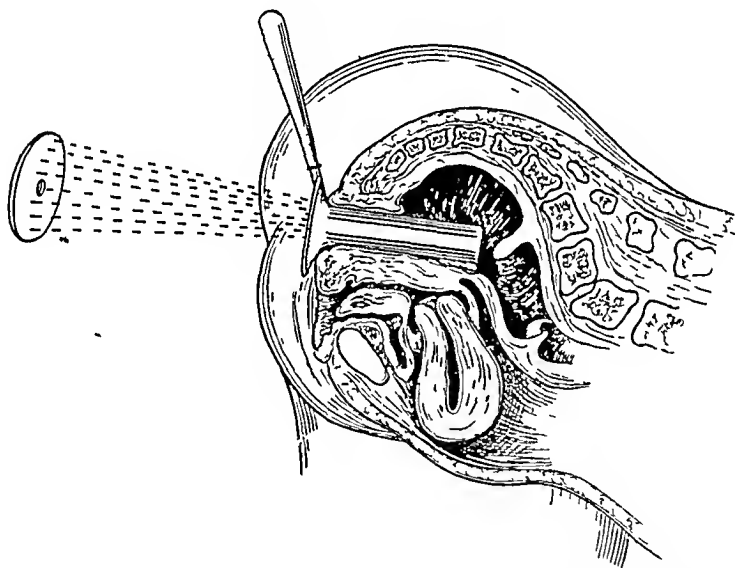


FIG 412 —EXAMINATION OF THE RECTUM BY MARTIN'S PROCTOSCOPE

The patient is in the genu-pectoral position, so that when the proctoscope is introduced air rushes in and distends the rectum, the observer, utilizing either an electric head-lamp or a laryngoscopic mirror, can easily see the interior. In the above diagram the projection of Houston's valves is clearly indicated.

as to prevent faecal matter from lodging, and vaseline may be applied both to the finger and to the anus to facilitate introduction. It is, of course, advisable to have the bowel unloaded by purgative or enema before an examination is made. The patient lies on the left side in the gynæcological position, and the introduction of the finger is usually less painful if he strains down at the same time.

A bimanual examination can be conducted with the finger in the rectum, and the other hand pressed deeply over the patient's hypogastrium. Although the great majority of rectal lesions occur within the lower inch and a half of the bowel, the surgeon must never omit to explore the upper part of the rectum, as an unsuspected polypus or tumour may often be discovered in this way, the pelvic plicae should also be included in the scope of the investigation.

2 The introduction of the whole hand has been recommended by some, but the hand must be unusually small which can be thus utilized.

3 Visual Examination is a most valuable proceeding. Martin's *proctoscope* (Fig 412) is the most suitable appliance to use for this purpose, but an ordinary Fergusson's speculum answers well. The patient is placed in the genu-pectoral or in an elevated lithotomy position, the former is preferable, in that it allows intestines and uterus to drop forwards away from the rectum. Two index fingers, well greased and held back to back, are then introduced into the bowel, and the anus well stretched in several axes, so that its muscular tone is lost for a time. The proctoscope can then be introduced, and it will be found that if the patient is in the correct position the rectum becomes ballooned by an influx of air, and its interior can be clearly seen, a head-lamp or a laryngoscopic mirror is sometimes useful in order to illuminate the interior. Houston's valves stand out

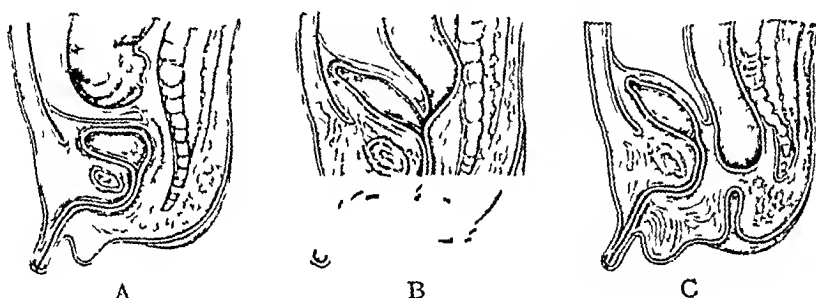


FIG 413—THREE VARIETIES OF MALFORMATION OF RECTUM (TILLMANN'S)

In A the bowel ends at the brim of the pelvis in a cul de sac, and there is no evidence of an anus. In B the anus is also absent, but the bowel opens into the bladder. In C the anus and bowel are only separated by a small space.

clearly, and often obstruct the view of the upper part, but they can usually be pulled aside by a hook, or pushed aside by the speculum, or even if necessary they can be divided. In this way 6 inches, if not more, of the bowel can be brought under the eye of the surgeon, and topical applications can be made.

**Congenital Malformations—Imperforate Anus or Rectum—**The lowest portion of the intestinal canal arises from the union of two separate divisions. The upper, developed from the lowest portion of the primitive hind-gut, is originally in communication with the bladder, and forms a joint cavity or cloaca, the two, however, being early separated, the posterior segment, which becomes the rectum, extends down into the pelvis, to be joined by an epiblastic pit or involution growing in from the perineum, known as the 'proctodeum'. Failures in typical development may be due either (a) to the proctodeum being absent or stenosed, (b) to the rectum being absent (Fig 413, A) or retaining in measure its cloacal condition and opening into some other viscus—e.g., the bladder, urethra, vagina, or vulva (Fig 413, B), or (c) to want of union between the upper and lower segments

(Fig 413, C) The following are the chief clinical varieties of malformation met with

(i) Absence of the anus, with or without development of the rectum, which, if present, may open in some abnormal situation. In such cases, the important question to be settled by the practitioner is the existence or not of a rectum, and this, unfortunately, cannot always be determined without an open exploration through the perineum, if, however, during crying and straining there is a distinct bulge in the middle line at the spot where the anus should be, there is every likelihood of the viscus being present. If so, it is always distended and club shaped, usually lined with peritoneum in front, and often below. If the rectum is absent, it usually ends near the pelvic brim, and is merely represented by a fibrous cord below that level (Fig 413, A), whilst the bony pelvis is often atrophic and its outlet much reduced in size. Thus in one such case an interval of only  $\frac{1}{2}$  inch was present between a sound passed into the urethra and the tip of the coccyx.

(ii) A membranous septum may persist between the upper and lower segments, placed about an inch from the anus, and allowing the retained meconium to push it downwards. This is the type of malformation most commonly observed (Fig 413, C).

(iii) An anus is occasionally present, whilst the rectum ends blindly above the pelvic brim, or opens elsewhere.

(iv) The anus, though present, may be contracted.

The **Treatment** of these cases must be instituted at as early a date after birth as possible, so as to prevent intestinal obstruction.

Anal stenosis is readily dealt with by regular dilatation with bougies.

Where a membranous septum persists between the proctodeum and rectum, a large trocar and cannula may be passed through it, and the meconium allowed to escape, the aperture thus made is enlarged, and maintained by the subsequent passage of bougies.

Where the anus is absent, whether there is any indication of the presence of a rectum or not, a *perineal incision* is first made through the site of the anus, and carried upwards and backwards along the concavity of the sacrum strictly in the middle line for not more than 2 inches. It is an open question whether it is justifiable to proceed further by removing the coccyx and part of the sacrum (Kraske's operation, p 1138), since the membranes of the spinal cord extend much further down in the infant than in the adult. If found, the dilated and bulbous cul-de-sac is drawn down as far as possible, and opened towards its posterior aspect, the mucous membrane is then, if feasible, stitched all round to the skin so as to leave no surface to granulate, thereby preventing subsequent stenosis. In cases where no rectum is present, *colotomy* must be performed, and by preference the iliac operation, since the space between the crest of the ilium and the last rib is exceedingly small in an infant. When once a passage for the fæces is established, abnormal openings into the bladder, etc., usually close without difficulty.

Various malformations in connection with the post-anal gut have been already described (p 722)

Injuries of the rectum are usually due to falling on some pointed body, such as a stick or railing, or upon a piece of broken china. They are sometimes due to the forcible introduction of foreign bodies by lunatics or criminals. They may merely involve the mucous membrane, or may penetrate the perineal tissues, enter the bowel, and penetrating the upper wall, lay open the peritoneal cavity. Hæmorrhage, pain, and shock follow, and acute peritonitis if the serous membrane has been encroached on. Inflammatory troubles may involve the peri-rectal tissues, and sinuses may result from suppuration. A thorough examination must be made under an anæsthetic, and the wounds either sutured or left open to granulate. In women the recto-vaginal septum may be torn, but the surgeon need be in no great hurry to interfere, since the opening usually closes as cicatrization progresses, in some cases, however, where the lesion is of some length, and the margins not bruised or inflamed, immediate suturing may be desirable. If the peritoneal cavity has been laid open, a laparotomy is usually required in order to cleanse it and close the wound, if, however, the wound is small and the rectum at the time of injury empty, it may be justifiable to delay interference till some sign of inflammatory reaction shows itself, a piece of sterilized gauze packing in the rectal wound will often suffice to limit the inflammatory mischief. Peri-rectal inflammatory complications are dealt with as they arise.

**Foreign Bodies** are derived from various sources. Most frequently they have been swallowed, and have traversed the intestinal canal. Fish-bones and small tooth plates are most commonly seen, and they usually lodge just above the anus in one of the so-called 'pouches of Morgagni'. They give rise to severe pain, especially on defæcation, and possibly to some form of peri rectal abscess. Large gallstones are sometimes lodged in the lower end of the rectum, just above the sphincter, as well as a Murphy button when it has been set free. Foreign bodies may be introduced from without, and cause various forms of traumatic inflammatory lesions.

**Inflammation of the Rectum** (*Proctitis*) causes pain of a bearing-down-character, a sensation of fulness, constantly recurring tenesmus, accompanied by a discharge of mucus, muco-pus, or blood. It may arise from any local source of irritation, e.g., the presence of foreign bodies, or of a polypus, parasites, or piles, gonorrhœa is an occasional cause—in women possibly owing to infection from the vaginal discharge, in men probably from direct infection. In dysentery the rectum is often involved as well as the colon, and extensive ulceration may be present. If the inflammation becomes chronic, a simple fibrous stricture may result. *Treatment* — Injections of lead and opium or of borax may be used locally, whilst the patient is kept in a recumbent position and on a low diet, the bowels being regularly opened by the administration of laxatives or enemata. If much bleeding is present, hazeline will often serve as a useful styptic.



**Thread-worms** (*Oxyuris vermicularis*) are the most constant source of irritation of the rectum in infants and children. They give rise to pruritus ani, a discharge of muco pus, and many reflex phenomena. In treating such a case, a sharp purgative may be given every morning (*e g*, pulv scammonia, grs v), and salt and water or an infusion of quassia used as an injection.

The *Bilharzia hæmatobia* is occasionally found in the rectum as well as in the urinary passages (p 1196). It gives rise to fibro adenomatous polypi, in which the ova can be readily demonstrated, they are rounded or oval bodies, differing from those found in the urine in that they possess a lateral spine-like projection, whilst in the latter it is terminal. Considerable tenesmus, diarrhoea and discharge of blood are present, and the hæmorrhage may become so abundant as to destroy the patient's life, especially when urinary symptoms

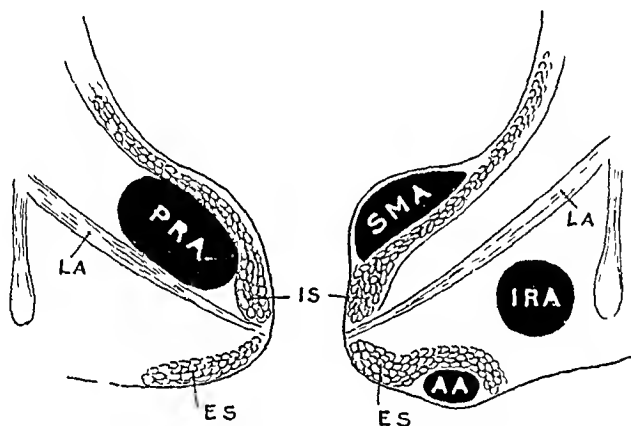


FIG 414 — DIAGRAMMATIC SECTION OF ABSCESES SITUATED NEAR THE LOWER END OF THE RECTUM

LA, Levator ani ES, external sphincter IS, internal sphincter, IRA, ischio rectal abscess, AA, anal abscess SMA, submucous abscess, PRA, pelvi-rectal abscess

are co-existent. They occur in children who have been in South Africa, and, unfortunately, no satisfactory treatment is known.

**Rectal and Peri-rectal Suppuration**—Many forms of abscess are found in and about the rectum, and inasmuch as they are very liable to leave behind troublesome fistulous tracks, it is important that they should be clearly described. As regards causation, they are, of course, due to germs, and these most commonly are derived from the bowel as a result of the impaction of foreign bodies, the extension of ulcerative processes, or the suppuration of piles. Occasionally the trouble starts from the skin around the anus, and sometimes the pus reaches the peri-rectal tissues from other viscera—*e g*, the neck of the bladder, prostate, etc—or from above in connection with spinal or pelvic abscesses. Not unfrequently the abscess is attributed to injury or to cold, as from sitting on a damp stone or a draughty

closet These latter, if having any influence, are merely the final exciting agents

1 An **Anal Abscess** forms immediately under the anal integument, and superficial to the sphincter (Fig 414, A A), it is usually due to inflammation of one of the numerous sebaceous follicles in that locality. It may be acute or chronic, and is one of the most frequent causes of fistula-in-ano. It must be freely opened throughout its whole length, and stuffed

Occasionally a sebaceous follicle becomes affected, constituting a boil, and may infect several others. If these can be dealt with early the trouble may be limited, but if neglected a somewhat extensive anal abscess may result

2 A **Submucous Abscess** (Fig 414, S M A) usually forms as the result of a suppurating internal pile. The pus spreads up and down under the mucous membrane, and gives rise to a blind internal fistula (Fig 416, 5). It is usually confined to one side of the bowel, and causes great pain on defæcation. Digital examination is extremely painful. Treatment consists in draining it at the most dependent spot, close to the anus, but it may be necessary to slit up the undermined mucous membrane in order to ensure healing. Considerable hæmorrhage may follow this proceeding, and it is not easy to stop except by firm pressure

3 **Acute Ischio-rectal Abscess** is due to infection of the loose fatty tissue filling the ischio-rectal fossa (Fig 414, I R A) with some pyogenic organism, reaching it either through the perineum or from the bowel. The *B coli* is usually present, and in consequence the pus has the ordinary characteristic offensive odour. A red, painful swelling is noticed on one side of the anus, which is at first hard and brawny, but soon becomes soft and fluctuating. Defæcation is exceedingly painful, as also digital exploration of the bowel, and the patient is unable to sit with any comfort. If left to itself, it may burst internally or externally, or in both directions, and a fistula-in-ano is very liable to follow. **Treatment**—In the early stages the part should be well fomented, but when there is no doubt that pus is forming, a free opening should be made, the cavity washed out, and stuffed with some antiseptic dressing. If taken early enough, rapid recovery may ensue without the bowel becoming involved, but when the mucous membrane has been encroached upon or perforated, the wound will not heal without division of the sphincter. A T-shaped or crucial incision is perhaps the best to employ in the early stages, as indicated in Fig 415, the cross limb of the T is parallel to the fold of the nates, and should extend through the whole of the inflamed and infiltrated tissues

4 **Chronic Ischio-rectal Abscess** is usually met with in run-down or tuberculous individuals during young adult life, and is not unfrequently a complication of phthisis. A deposit of tuberculous material replaces the fat ordinarily occupying the ischio-rectal fossa, and this after a time undergoes caseation or forms an abscess, which gradually spreads without pain or other inflammatory disturbance, until it

may extend very widely and almost entirely surround the bowel. After it has burst, the orifices of sinuses may be found at a considerable distance from the anus. The **Signs and Symptoms** are those of a chronic tuberculous abscess. An indurated and painless mass may be first felt in the fossa, and this slowly spreads, softens, and is transformed into a more or less extensive abscess sac. The **Treatment** is as for all tuberculous deposits, viz, in the early stages, and if possible before suppuration has occurred, incision, removal by a sharp spoon of all tuberculous tissue, the application of pure carbolic acid, and dressing the wound with gauze infiltrated with iodoform. Where extensive sinuses or fistulæ exist, treatment as for fistula in ano must be adopted. At the same time, suitable hygienic treatment is instituted, and the more so if physical examination of the

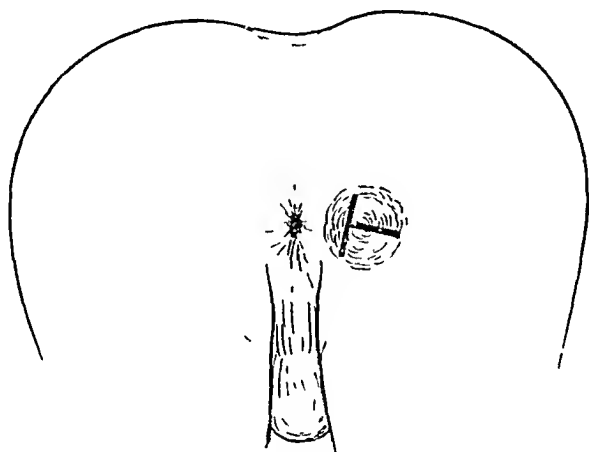


FIG 415.—SITUATION OF T SHAPED INCISION REQUIRED FOR THE OPENING OF AN ISCHIO RECTAL ABSCESS

lungs or bacteriological examination of the sputum indicates the existence of pulmonary tuberculosis.

5 The **Pelvi-rectal Abscess** (Fig 414, P R A) consists in a localized collection of pus in the loose cellular tissue above the levator ani and between it and the rectum. It may be secondary to rectal lesions, such as penetration of the wall above the internal sphincter or extension of ulceration from a carcinoma, but not uncommonly it originates from pelvic lesions, and may be caused by pelvic cellulitis, or suppurative lesions in the meso-rectum, prostate, etc. The ordinary phenomena of deep suppuration are produced, and the pus may burrow downwards through the levator ani to the ischio-rectal fossa, or may travel up and involve the pelvic peritoneum. Sometimes it extends laterally and may almost surround the bowel, causing one type of horse-shoe fistula. Other collections of pus may find their way into this region from distant parts—e g, a psoas abscess from spinal disease, appendix abscesses, etc. Rectal examination indicates the existence of a painful swelling high up in

the bowel As soon as a diagnosis is made, the abscess should be freely laid open and drained, and if possible by an incision behind the anus Of course an abscess which is secondary to a tuberculous spine is an exception to this rule, in this every effort must be made to prevent the necessity for an opening in this region, as infection is certain to follow

6 Occasionally a *diffuse* form of cellulitis involves the peri rectal connective tissue, not uncommonly resulting in gangrene (*gangrenous periproctitis*) It is most likely to be seen in weakly individuals and old people, and the symptoms are very asthenic in type The suppuration may extend above the levator ani, and lead to deep fistulous tracks The parts must be freely opened up, the gangrenous tissue scraped away, and the raw surfaces treated with peroxide of hydrogen The wounds are then stuffed with iodoform gauze, and subsequently

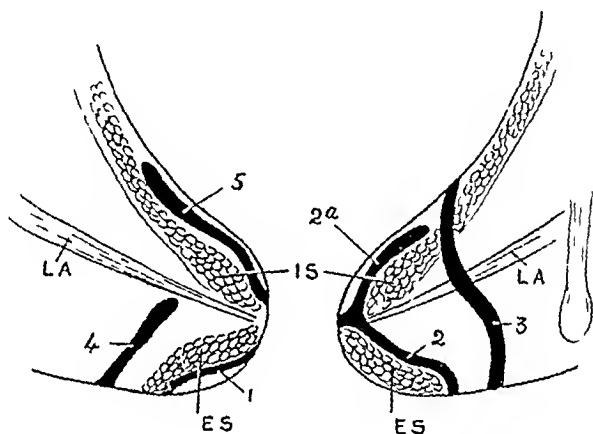


FIG 416 —DIAGRAMMATIC REPRESENTATION OF VARIOUS FORMS OF FISTULA-IN ANO

- 1 Superficial fistula resulting from an anal abscess, 2, a complete fistula, not involving the internal sphincter 2<sup>a</sup> secondary track burrowing under mucous membrane 3 complete fistula opening above the internal sphincter and traversing the levator ani, 4, blind external fistula 5, blind internal fistula, ES, external sphincter IS, internal sphincter LA, levator ani

well irrigated twice a day Free stimulation is always required in these cases, but the prognosis is very bad, death being probably caused by acute toxæmia or pyæmia

**Fistula-in-Ano**—The term fistula-in-ano is somewhat loosely applied to all those conditions in which suppurating tracks are found in the neighbourhood of the anus and the lower end of the rectum Many of these are merely sinuses which have but one opening

The Cause of fistula is usually some suppurative condition, *e g*, an ischio rectal or anal abscess, in the neighbourhood of the bowel, but it is sometimes the result of a stricture of the gut, the inner opening being either above, in the substance of, or below the cicatricial mass This is more likely to be the case when multiple fistulæ exist

**Varieties**—1 The *Complete Fistula* is one in which there are open-

ings both externally and into the bowel. When following an anal abscess, they are both close to the anus, and the track lies immediately beneath the skin and mucous membrane (Fig 416, 1). When following an acute ischio-rectal abscess, the external opening is a variable distance from the anus, and the inner not more than 1 inch up the bowel, being situated in relation with the so-called internal sphincter (Fig 416, 2), occasionally blind submucous or subcutaneous extensions are met with branching off from this (2<sup>a</sup>), but not so frequently as when the fistula follows a chronic tuberculous abscess. In the latter case the skin may be extensively undermined, looking blue and congested, and the fistulous tracks may burrow widely, opening even on the thigh, or in the perineum or buttock. The so called *horseshoe fistula* passes round the bowel, usually behind the anus, either superficial to the external sphincter or beneath it, and opens also on the other side. Moreover, the mucous membrane of the bowel is often undermined, and stripped from the muscular coat for some distance above the internal opening by sinuses or an abscess cavity. Occasionally the complete fistula which follows an ischio-rectal or pelvi-rectal abscess opens some way up the bowel as well as externally, and traverses the levator ani (Fig 416, 3), constituting a much deeper and more serious lesion.

In any of these conditions secondary tracks may form, burrowing in all directions, and sometimes the opening up of these passages is a serious matter. Thus they may run forwards to the scrotum, or outwards into the gluteal region.

2 The *Blind External Fistula* (Fig 416, 4) is the term applied to a sinus resulting from the opening of an ischio-rectal abscess in which no communication with the bowel can be discovered. A probe passed into the wound can often be felt by a finger in the rectum with only the thickness of the mucous membrane between. In dealing with these external fistulae the possibility of the original cause being at a distance must not be overlooked.

3 The *Blind Internal Fistula* (Fig 416, 5) is constituted by a sinus opening into the bowel just above the anus. Attention is usually drawn to the condition by the passage of pus with the motions or independently, and perhaps by preceding inflammatory disturbance. The orifice can sometimes be felt by digital exploration, and on the insertion of a speculum may perhaps be seen and carefully examined by a straight probe or one bent in the form of a hook, it is often associated with considerable undermining of the mucous membrane, and if chronic with stenosis of the bowel.

In all these conditions it is very difficult to obtain healing, owing to the introduction of septic material from the bowel, and to the state of unrest in which the parts are kept by the continuous movements, voluntary and involuntary, of the sphincters.

**Operation** — The bowels must have been completely evacuated, both by means of castor oil or some suitable purgative, and about an hour previous to operation by enema, a most important preliminary, not only for the comfort of the operator, but also because it is very desirable that no further action should be required for some

days The patient is placed in the lithotomy position, and the perineal and anal regions shaved and purified A probe is passed along the fistula into the rectum, and guided by it a grooved director, along which a curved pointed bistoury is introduced, and the intervening structures divided In a superficial fistula, both sphincters may escape division, and in a deep one both may be involved, in the majority of cases, some fibres of the external sphincter are divided A careful search is made for pockets or tributary branches of the main track, and such, if found, are opened up and scraped out, undermined and unhealthy skin being snipped away with scissors, bleeding points are, if necessary, tied, and the cavity carefully powdered with iodoform, and lightly stuffed with oiled lint or gauze soaked in iodoform and glycerine Pressure by a graduated compress of sterilized wool should be applied by means of a T-bandage

When a sinus extends for some distance under the mucous membrane from the upper end of the original fistula, it may not be always desirable to lay it open to its whole extent, since such might involve serious hæmorrhage at a spot where it cannot well be checked It will often suffice partly to divide and scrape it, and then, if the main fistula has been satisfactorily dealt with, it will probably heal without difficulty, especially if syringed out occasionally with stimulating lotions

In the case of a horseshoe fistula, the sphincter need only be divided at one spot, and that usually in the middle of the horseshoe The whole track must, however, be opened up, the cavity scraped, loose tags of skin removed by the scissors, and an ordinary dressing applied

A small superficial fistula, not extending beyond the anal margin, can sometimes be entirely excised, and the wound closed by sutures, thereby securing healing by primary union

**After-Treatment** — The bowels should, if possible, be prevented from acting for four days, and most scrupulous care taken to keep the parts clean The deep dressing need not be changed for the first twenty-four or forty-eight hours, provided that the surrounding skin is well flushed with a warm carbolic solution When the plugs are removed, fresh small strips of gauze soaked in iodoform and glycerine are introduced night and morning after the wound has been syringed On the fourth day a good dose of castor oil should be given, and subsequently care taken to secure an action of the bowels daily The wound is allowed to granulate, and care taken that irregular healing does not lead to a re formation of the fistula With this object in view, it is often advisable to pass a moderate-sized bougie from time to time at the end of a fortnight

When the incision is not carried very deeply, the patient's sphincteric control after operation is unimpaired, but if the internal sphincter has to be divided, all control of the bowel is lost for some time As cicatrization progresses, however, it is gradually restored, and when healing is complete, control is usually perfect except when the patient is suffering from diarrhoea

The presence of tuberculous material locally and in the lungs must be carefully considered and taken into consideration in advising

operation If the pulmonary trouble is early, there is no necessity for delaying operation, the patient will derive much more benefit from a stay in country air if his fistula has first been cured In the later stages, however, it may be advisable to leave the fistula alone, or, at any rate, only to do such an operation as shall relieve any urgent symptoms

**Fissure of the Anus**—This is a most painful and troublesome complaint, met with most commonly in men, though not unfrequently in women of a neurotic temperament It is occasionally due to injury or to the irritation of a polypus, but more often to the passage of large scybalous masses in patients suffering from chronic constipation The fissure is usually single, extending through the posterior border of the anus toward the coccyx, a 'sentinel' external pile is often situated immediately over it, and the crack may lead to a definite ulcer just within the external sphincter According to Ball of Dublin, it is due to one of the valve-like tags, left at the junction of the proctodeum and rectum, being caught by a scybalous mass, and torn from its upper connections Each time a motion passes the sore place is reopened, and the valve pushed further on, until finally, having become swollen and oedematous, it appears at the orifice as the 'sentinel' pile, with an ulcerated surface behind or beside it Sometimes several fissures are met with in the same individual, and then a syphilitic cause is probable, especially if they are placed at the side or front of the anus

The **Symptoms** of this condition are very distressing, consisting of burning pain during defæcation, which often lasts for some hours The pain is usually associated with tenesmus, and may radiate down the thighs or up the back, and not uncommonly to the left sacro iliac joint, it may be so severe as to lead the patient to refrain from defæcation for prolonged periods The fæces may be streaked with blood or pus, and there is a certain amount of discharge from the anus On examining the part, the sphincter is found to be spasmodically contracted, and the entrance of a finger is forcibly resisted

**Treatment** in the earlier stages is undertaken by regulating the action of the bowels by suitable laxatives, by the use of cocaine suppositories prior to defæcation, and by improving the general health Sometimes the application of a hamamelis ointment, combined with the ung hydrargyri nitratis dil, is most effective in giving relief In confirmed cases the sphincter has been forcibly dilated by the thumbs, and the crack or ulcer cauterized, but by far the most efficient treatment consists in dividing its base with a straight probe-pointed bistoury, the incision at the same time including the external sphincter The ulcer and the edges of the wound are snipped away with scissors, to facilitate the dressing and healing of the wound The lower bowel should in all cases be carefully explored with the finger, especially with a view to the possible existence of a polypus, which, if undetected, would cause a recurrence of the mischief Rest being thus obtained, healing soon follows It is sometimes possible to close this small wound with sutures and obtain primary union

**Tuberculous Disease of the Rectum** occurs in the form of ulcers, which are usually multiple, and may be very extensive. Infection may be due to the swallowing of infected sputum, but is probably the result of dissemination by the blood, the affection is usually secondary to pulmonary disease. It starts in the submucosa, and the ulcers which follow have the usual features, with undermined edges and prominent granulations. There is usually a marked tendency to the production of fistulæ by extension of the process outwards. The symptoms are those of rectal irritability, pain on defæcation, and discharge of muco-pus and perhaps blood. Treatment is usually palliative, the rectum being emptied by enemata or medicine according to the patient's comfort, and possibly healing ointments introduced. In the worst cases, colostomy may be required in order to put the bowel at rest.

**Syphilitic Disease of the Rectum and Anus** — The rectum and anus are attacked by syphilitic disease in a variety of ways, the most prominent being as follows

(a) The initial lesion or primary chancre is occasionally met with in the neighbourhood of the anus.

(b) In the secondary stage mucous tubercles or condylomata are frequently seen, being placed either at the anal margin or symmetrically on either side of the gluteal fold, the sores on one side having evidently infected the other. They are of the usual type (p 143), and are treated by dusting with powdered calomel, and keeping a piece of dressing between the lips of the fold.

(c) In the tertiary period *diffuse syphilitic disease of the rectum* is not uncommon, occurring most usually, but not solely, in young married women of the poorer classes. It is a somewhat early tertiary manifestation, and usually commences within easy reach of the finger, about 3 inches from the anus. It starts as a diffuse gummatous infiltration of the rectal mucous membrane and submucous tissue, which become thickened and indurated, ulceration soon following. These phenomena are not limited to the rectum, but frequently spread up the intestine towards the sigmoid flexure and down to the anus, and likewise involve the recto-vaginal septum and vagina, passing down the latter canal to invade the perineum and neighbouring structures, so that in a neglected case the whole external genitals and anus may be involved in an irregular hypertrophic mass, somewhat resembling elephantiasis. In addition, the ulcerative process may extend more deeply, leading to the formation of fistulæ, not only between the rectum and neighbouring viscera (*e.g.*, vagina or bladder), but also communicating with the exterior. From the cicatrization occurring in the submucous tissue, contraction of the gut results, causing a *syphilitic structure*, which may extend for some distance up the bowel. The symptoms consist in pain, increased on defæcation, irritability of the bowel, and discharge of blood and pus by the anus, whilst obstructive phenomena, or alternating attacks of constipation and diarrhœa, may also be present. On examination, the diffuse ulceration and infiltration of the part are suggestive of



malignant disease, but the patient's age and history, and the course of the case, are usually sufficient to determine the diagnosis. The general health remains good in the earlier stages of the affection, but later on may be undermined by the pain and constant purulent discharge.

**Treatment** consists in administering mercury and iodide of potassium, the former perhaps in the shape of suppositories, whilst locally dilatation by bougies is necessary. In advanced cases colostomy is essential in order to secure rest to the parts, and give them a chance of healing. Possibly in a few instances only a temporary opening of the bowel may be required, but where much contraction exists and a considerable tendency to obstruction, the artificial opening must remain permanently. Sometimes the ulceration persists in spite of colostomy, and care must then be taken to prevent the retention of discharges by the occasional passage of bougies.

**Fibrous Stricture of the Rectum** is usually met with in advanced life, especially in women over forty years of age, and is most often situated 2 or 3 inches from the anus, or as high as its junction with the sigmoid flexure. In this position, it is usually due to the cicatrization and contraction of ulcers following prolonged diarrhoea and dysentery, although occasionally it follows tuberculous or syphilitic disease. Any form of chronic proctitis, *e.g.*, gonorrhoea, may also lead to it. It occurs sometimes as a sequela of pelvic cellulitis and suppuration, from the contraction of fibrous bands which may bind the rectum backwards to the sacral wall, or may merely constrict it, the stricture is in these cases usually at a lower point than in the former. Repeated attacks of inflamed piles may also lead to stenosis at or just above the anus. A stricture sometimes results from traumatism, or follows operations involving the whole or at any rate the greater portion of the circumference of the bowel. As already mentioned, it may be associated with a fistula, especially if the latter has existed for long, the inner opening may then be found in the substance of the stricture, as pointed out by the late Mr Henry Smith.

The earliest **Symptoms** of stricture are often alternating attacks of diarrhoea and constipation, in which, of course, the constipation is primary, and the diarrhoea due to a catarrhal enteritis arising from the irritation of the retained faeces. Gradually the difficulty in passing motions becomes more and more marked until no relief is obtained apart from medicine, the faeces themselves become narrowed, flattened, and elongated, something like pipe-stems, or small masses like shrimps may alone succeed in passing. This is associated with pain and uneasiness referred to the lower bowel, a certain amount of blood and mucus may be mixed with the excreta, and sooner or later marked dyspepsia and abdominal distension supervene. If the case is allowed to run on without treatment, absolute obstruction of a chronic type may result, and lead to a fatal issue, or the mucous membrane of the bowel above the stricture becomes ulcerated, an abscess forms, and subsequently a fistula, through which a certain small amount of faecal material passes. If several of these fistulae

are established, the patient may finally succumb to chronic septic poisoning and exhaustion

An examination of the bowel with the finger may reveal a smooth, regular constriction of the gut as if a band had been tied round it, the fibrous mass and the aperture in it feeling something like an os uteri. In other cases, the bowel is stenosed for some distance, and its surface more or less ulcerated, whilst if due to pelvic cellulitis, it may be drawn up and fixed to the posterior pelvic wall. When the stricture is too high for the finger to reach, the gut may appear normal, though somewhat dilated (ballooning). Sometimes the stricture is smooth, and free from nodular irregularities and excrescences, often, however, it is ulcerated and irregular, the examination causing great pain. The gut above the contraction is hypertrophied and distended, whilst if filled with retained fæces, the mucous membrane may show signs of inflammation, or even stercoral ulcers. The gut below the stricture is usually dilated (ballooned), partly from paralysis of its walls, and partly by invagination of the mass from above.

The **Treatment** in the early stages consists in keeping the bowels regular and the motions soft by means of laxatives, such as castor oil or saline, whilst the passage of the excreta is assisted by enemata. The diet is regulated, and the strength maintained, if need be, by tonics. Locally, the stricture, if within reach, should be dilated by means of bougies passed in increasing sizes every two or three days, care being taken that the point of the instrument engages the stricture, and is not caught against folds of mucous membrane or turned backwards. The utmost gentleness must be used, in order, as far as possible, to stretch the mucous membrane, and not tear it. Laminaria or compressed sponge-tents are of use in some cases, followed subsequently by bougies. When situated low down, the stricture may be notched posteriorly, or slightly nicked in several places with a probe-pointed bistoury, and bougies then passed. There is always a great tendency in these strictures to contract again, and the patient should be instructed to pass a bougie for himself at short intervals. If the stricture is out of reach, or signs of obstruction manifest themselves in spite of treatment, colostomy is the final resource.

**Tumours of the Rectum** — **Polypus Recti** occurs most frequently in children, and consists usually of an adenoma of Lieberkuhn's follicles, but occasionally of simple fibrous tissue covered with mucous membrane. They are commonly found within easy reach of the anus, and present an appearance something like a small cherry with a long pedicle, pendulous and freely mobile. The **Symptoms** caused are irritability of the bowel and the passage of blood by the anus, which latter when occurring in a child without symptoms of obstruction is almost pathognomonic of polypus. The tenesmus excited may lead, as mentioned elsewhere, to prolapse or to the occurrence of an intussusception. It is occasionally associated with a fissure of the anus, which probably arises as a secondary result of the irritation caused by the partial extrusion of the polypus during defæcation. A natural cure can be effected by rupture of the attenuated pedicle, which is at

first attended by a certain amount of hæmorrhage **Treatment** — The polypus is cut away after tying or twisting its pedicle, or the clamp and cautery may be employed

**Papilloma** of the rectum is a rare disease, and gives rise to hæmorrhage from and irritability of the bowel, or, if large, even to obstruction This condition is not always limited to the rectum, but may extend through the greater portion of the intestine, and then proves fatal from hæmorrhage **Treatment** consists in removal by ligature or wire snare, where practicable

**Sarcoma** is another uncommon disease in the rectum It occurs in the shape of a large fleshy tumour growing from the submucous tissue, and projecting into the lumen of the gut so as to cause obstruction It is less painful than cancer, and usually occurs at an earlier age The symptoms are much as in the latter disease, and the treatment, when feasible, is the same, viz, extirpation of the growth, but it will very probably recur

**Epithelioma** of the Anus (*i.e.*, of the skin covering the anal margin) occurs as a primary development similar to that on the lip, and is then of the squamous type It presents the usual features, viz, an indurated nodular mass, which readily ulcerates, and runs the typical course of such a disease, infecting the inguinal glands It is readily dealt with in the earlier stages by an operation somewhat similar to that for excision of the rectum

**Cancer of the Rectum** appears in the form of columnar carcinoma, consisting, as described elsewhere (p 208), of an overgrowth of Lieberkuhn's follicles, not only into the lumen of the gut (centrifugal or papillomatous type of growth), but also invading the deeper portions of the bowel wall, infiltrating the submucous and muscular layers (centripetal growth) A vascular fibro-cellular stroma is found between the glandular acini, and the physical characters of the tumour are largely dependent on the relative amount of these two elements Thus, (*a*) if the stroma is abundant and fibro-cicatricial, the growth is comparatively slow, the tumour is hard and nodular, it usually starts on one side of the bowel as a malignant wart-like mass, but gradually encircles the gut, and is always likely to produce obstructive phenomena from its contraction, ulceration occurs after a while (*b*) In the softer, more rapidly-growing type, the stroma is less abundant, and merely fibro cellular in character The tumour projects into the bowel, and early involves the whole circumference, ulceration and bleeding are constant features, and the pain is usually considerable There is always greater destruction of tissue, so that obstruction to the onward passage of fæces is much less likely to occur in it than in the former type, where cicatricial contraction is a marked feature The ulcer which develops in the bowel is of the usual malignant type, with an excavated surface and indurated everted edges (Fig 417), it bleeds readily, and its investigation is very painful Colloid degeneration is occasionally seen in cancer of the rectum

As the disease progresses, it invades surrounding parts, and thus the tumour may become adherent either to the pelvic walls or to the

bladder, vagina, or prostate, sometimes the iliac vessels or sciatic nerves are compressed, causing œdema or neuralgia respectively. Of course, it must be understood that this invasion is in part inflammatory and due to absorption of bacteria, etc., from the ulcerated surface, and this is always a grave addition to the case. Peri-rectal abscesses and fistulæ sometimes form, opening externally in the ischio-rectal fossæ, or perhaps internally into the bladder or vagina, and then the tumour begins to develop along the line of the fistula, and may actually form a mass of some size in the bladder.

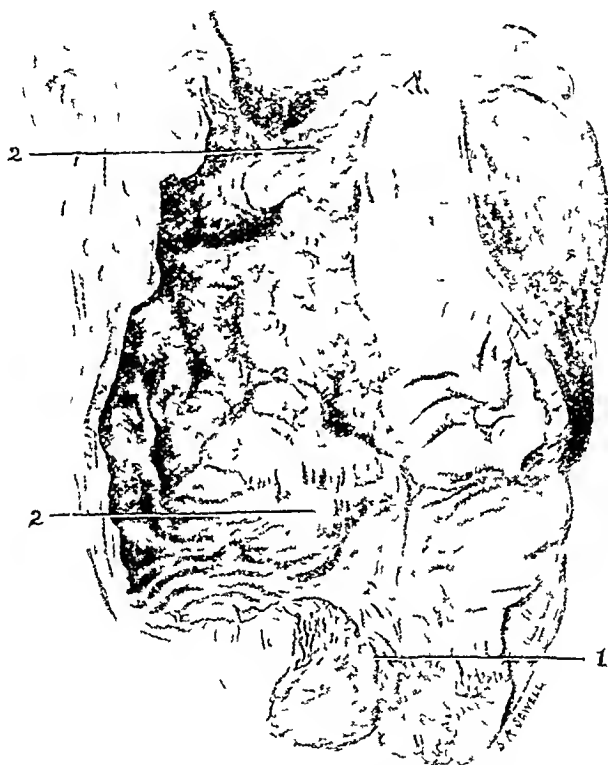


FIG 417 —CARCINOMA OF THE RECTUM (KING'S COLLEGE HOSPITAL MUSEUM)

1 Anus, split open posteriorly 2 2, margins of the ulcerated growth

The glands in the meso-rectum and the lumbar glands become enlarged, but for a time this may be merely inflammatory in type, later on, it is of a cancerous nature. Not unfrequently it leads to contraction of the meso-rectum, in consequence of which the bowel is drawn back towards the posterior pelvic wall, and more or less fixed there—an important diagnostic sign in some cases. Anal cancer, of course, leads to involvement of the inguinal glands. Secondary deposits may also be found in the liver, but this is not very common, and may even be disseminated throughout the body, though this is decidedly rare.

The Symptoms of the disease are often so slight and the onset so insidious as to raise no suspicions of the existence of any growth until it has attained considerable size. The patient is usually an adult, and more often male than female. At first there may be merely some slight constipation, requiring an increased amount of opening medicine. Then may come more definite attacks of constipation, alternating with diarrhoea, and the discharge of large quantities of mucus, often blood-stained. A sense of weight or dragging pain is noticed in the rectum, and the patient after defæcation feels as if there is still something to be passed. This sensation increases until true tenesmus and straining at stool are present, together with constant pain, which may radiate up the back and down the legs, causing sitting on any hard substance to be painful. At first a blood-stained discharge may be seen on the fæces, which become flattened and pipe like, if stenosis is present, but later it passes independently of the motions. On examination, an ulcerating, crateriform mass is met with, which may either be limited to one segment of the gut wall, and is then usually firm, and perhaps associated with stenosis, or it may surround the bowel, and feel soft and spongy, readily breaking down under the finger, and bleeding freely. The bowel below the growth is usually 'ballooned'. This examination is generally painful, as also the process of defæcation, and sometimes the patient abstains from the latter for lengthened periods on account of the exquisite agony caused thereby. When the anterior wall is involved, the bladder is often fixed to the mass, and micturition becomes painful, moreover, every time the bladder is emptied a discharge may occur from the bowel, and this may continue even after colostomy has been performed. Marked cachexia supervenes, the digestion becomes impaired, any meal causing pain and flatulent distension, natural sleep is impossible, and if a rectovesical fistula forms, the patient's troubles are further aggravated by the passage of fæces and flatus by the urethra.

The case runs a more or less rapid course to the fatal issue, which on an average ensues about seventeen months after the onset of symptoms, if no operation has been undertaken (Jessop\*), and may be due to a variety of causes. Fæcal obstruction occurs in about 30 per cent of the cases, being more marked in the chronic forms, and in those where the disease starts high up the bowel, on account of the peristalsis causing invagination of the mass and occlusion of the tube, whilst if ulceration is excessive, or the disease situated low down, obstruction is much less common, invagination being here impossible, and peristalsis being expended on the onward passage of the fæces. Exhaustion, from hæmorrhage, pain, sleeplessness, or septic absorption, accounts for most of the fatal results, whilst septic peritonitis following the perforation of stercoral ulcers above the growth occurs in a few instances.

The Treatment of cancer of the rectum consists in the radical measure of excision of the mass, or in the palliative operation of colostomy

Excision of the Rectum, or proctectomy, is only applicable to those cases in which there is a reasonable prospect of the whole disease being eliminated. This depends not on the upward extent of the growth but on the question of fixation to surrounding parts. When the mass is not fixed anteriorly so as to endanger other viscera, *e.g.*, the prostate or bladder, the case is a favourable one for excision. Fixation of the mass laterally or behind is not so important, although it will prevent removal, if extensive. Enlargement of glands in the meso-rectum does not necessarily contra-indicate operation, as they may be merely inflammatory and not invaded with malignant disease, and can be included in the scope of the high operation. When the lumbar glands are involved, or the liver, a radical cure by excision cannot be expected, and it is probably wiser not to attempt it, even if the local signs are favourable. Formerly it was considered of vital importance to avoid opening the peritoneum, but at the present day this is frequently done, and with no untoward result, if due precautions are taken, so that, although the growth may be situated high up, if it is freely moveable, and there is no evidence of secondary deposits, an attempt should be made to take it away. It must be remembered that in the male the peritoneum is reached on the anterior aspect of the gut about  $2\frac{1}{2}$  inches from the anus with an undistended bladder, whilst it *may* be pushed up another inch when that viscus is full, in the female the peritoneum is situated about 4 inches from the anus, being reflected to the posterior aspect of the cervix uteri. Posteriorly, the lower 4 or 5 inches of the bowel are uncovered by serous membrane in both sexes.

It is good practice to anticipate the radical operation by a preliminary colostomy, unless the case is a very early one. Where the whole circumference of the bowel has to be removed for 3 inches or more, and the operation involves the anus, the passage of faeces through the wound is not only a source of septic contamination, but also causes extreme pain, whilst the condition subsequently left is almost certain to err on the side either of patulency or of contraction, and there is total loss of control. An effective anus in the iliac region obviates all these difficulties, whilst the preliminary operation gives the surgeon a chance of investigating the condition of the lumbar or sacral glands, and of ascertaining the extent of the growth up the bowel. If, however, the anal canal is free, it is possible to remove the growth by the high operation, and to unite the upper segment to the lower, thereby restoring the continuity of the intestinal canal. Under such circumstances colostomy may be omitted as a preliminary, or at any rate only undertaken as a temporary measure. Should the union between the two segments fail and a sacral anus develop, colostomy can always be resorted to at a later date.

Two forms of operation are described, according to whether the growth is situated high up or low down. The latter, or low operation, sometimes known as Langenbeck's, is performed through the perineum, the former, for dealing with cancer situated higher up,

necessitates partial removal of the sacrum or coccyx, and is known as Kraske's

1 *Low Operation*—The rectum having been thoroughly washed out and emptied, and the patient placed in the lithotomy position, the perineum is shaved and purified, and the posterior wall of the rectum and anus slit open in the middle line as far as the tip of the coccyx. An incision is now made all round the anus at the junction of the skin and mucous membrane, if the anus is healthy, when diseased, the incision is extended beyond the margin so as to include the growth. The rectum, together with the tumour, is then separated from surrounding structures by scissors and fingers, commencing posteriorly, where this is readily effected, dividing the levator ani on each side, and working gradually upwards and to the front, where greater care must be taken to protect the vagina, prostate or membranous urethra. In the male, a bougie or catheter may be passed into the urethra with advantage. Bleeding points can be secured during this process by pressure forceps. The upper attachments of the gut are divided either by scissors, écraseur, or clamp and cautery. Hæmorrhage, which is generally very free, is arrested by ligature or cautery, and the gaping wound powdered with iodoform, and plugged for twenty-four hours with gauze, the posterior incision not being closed by suture, and no attempt made to drag down the mucous membrane. Subsequently the wound may be left without any internal dressing, an external pad of salicylic wool sufficing, it is thoroughly washed out two or three times a day with some dilute antiseptic, such as sanitas (1 in 10), Condy's solution, or carbolic acid lotion (1 in 60), which may be used alternately, granulations gradually cover the surface, and, as cicatrization progresses, the mucous membrane is by degrees approximated to the skin margin, and the patulous cavity diminished in size until healing is complete.

If the growth affects one side of the gut alone, the operation is modified by only removing that half. If fixed posteriorly, the coccyx, and even a part of the sacrum, may be taken away without hesitation to facilitate the extirpation of the mass.

2 *Kraske's or the High Operation*—The patient reclining on his right side, an incision is made in the median line from just behind the anus to the middle of the sacrum, but without opening the bowel. The coccyx is excised, and the great sacro-sciatic ligament and gluteus maximus detached from the left side of the sacrum. Part of the left wing of the latter bone is now removed by chisel and hammer, the incision being curved, and extending from the median line below, through or above the fourth posterior sacral foramen to the under border of the third, and then to the left border of the bone at that level (Fig 418, *a b*). The loose cellular tissue behind the rectum is thus exposed, and the gut, together with the tumour and the enlarged glands in the hollow of the sacrum, is freed from its connections, and amputated from the sound gut above, the peritoneum being usually encroached on in this stage of the proceedings.

A strip of sterile gauze is packed in to protect the cavity from infection, and the opening is subsequently sutured up. If the growth extends to the anus, the whole length of the rectum below is excised, and then the upper segment is drawn down and sutured to the skin. If the sphincter and lower inch or two are free from disease, they are left *in situ*, and carefully sutured to the lower end of the upper segment, although it is very probable that union will not occur. The wound is carefully washed out, and stuffed with gauze sprinkled with iodoform, even if the peritoneal sac has been opened, no harm will usually come of it. The results which have followed this severe operation are, on the whole, encouraging.

Various modifications of Kraske's proceeding have been suggested, one of the best being that performed by Bardenheuer. The sacrum

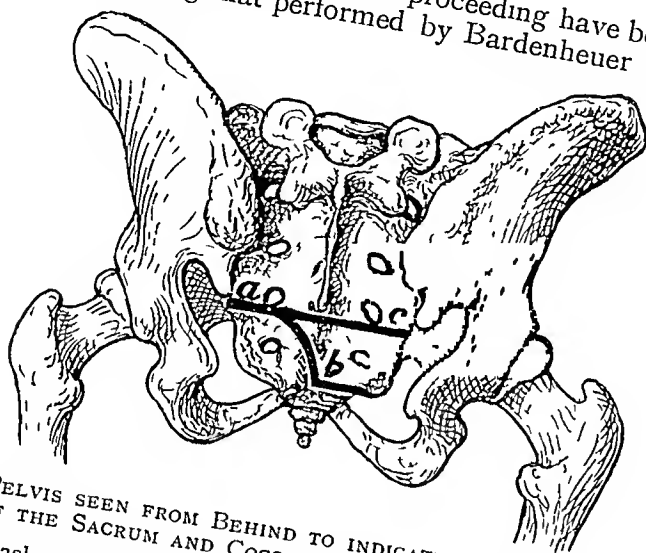


FIG 418 — PELVIS SEEN FROM BEHIND TO INDICATE THE LINES OF SECTION OF THE SACRUM AND COCCYX IN KRASKE'S OPERATION  
a b Kraske's original operation a c Bardenheuer's modification

is exposed, sawn across just below the third foramina (Fig 418, a c), and the portion thus detached is totally removed. By this means a much more extensive view is obtained of the pelvic contents, and the scope of the operation increased.

Excision of the rectum is a proceeding only practicable in comparatively few cases of the disease (Jessop states 15 to 20 per cent), and fatal results may follow from shock, hæmorrhage, or peritonitis. After the low operation the tendency to recurrence is considerable, but the disease is not then so painful as before, since the nerve terminals have been removed. In the cases that are cured a certain amount of inconvenience is certain to follow from either a patulous or a stenosed condition of the anal orifice, and it is still a moot point whether in many cases a simple colostomy is not as valuable as excision.

As already stated, if the radical operation is not feasible, Colostomy is the only means whereby the patient's condition can be temporarily



ameliorated The surgeon should not wait until urgent symptoms develop, but the operation may be justifiably undertaken at an early date for the following reasons (a) It allows the patient to indulge in solid food, and thus assists in maintaining the general health, (b) it frees him from the pain arising from the passage of fæces over the ulcerated surface, (c) it may possibly retard the growth of the disease by eliminating the irritating action of the fæces, (d) it removes all chance of intestinal obstruction from the growth itself, and (e) it diminishes the absolute risk of the operation by doing it when the patient is comparatively well and hearty, and when there is no urgency Formerly, when undertaken for obstruction alone, the death-rate was about 30 or 40 per cent, in an early iliac operation it is now practically nil, or at most 3 or 4 per cent On the other hand, the surgeon must not promise the patient too much as the result of a colostomy (a) It may not relieve the pain at all, as this is not unfrequently due to the implication of nerves which are dragged upon by the growth (b) The discharge of muco pus and blood may continue unchecked, causing tenesmus and constant calls to empty the bowel below the artificial opening This condition usually obtains in the soft ulcerative type, and the additional attention required by the colostomy wound may make the patient's life a burden to him Colostomy gives its best results in the chronic type tending to stenosis, in the ulcerous soft form it must not be undertaken without due consideration For details as to colostomy see p 1019

Should the patient refuse colostomy, or should it be for any reason contra-indicated, treatment consists in limiting the diet to such materials as strong broths, arrowroot, etc, with some stimulant, so as to give as little fæcal remains as possible, and to enable him to do without an action of the bowels for about a week at a time The strength is husbanded by keeping him in bed, and pain is checked by the administration of morphia

**Hæmorrhoids, or Piles,** consist in a varicose condition of the veins surrounding the anus and lower inch or two of the rectum

The character of the blood-supply of this portion of the bowel, and the conditions under which it is carried on, go far to explain the frequency of this affection The circulation in the lowest portion of the colon is similar to that in the intestine generally, the vessels being distributed transversely around the gut, but in the rectum they run in longitudinal series along the bowel, being connected by transverse branches, which form a plexus around and just above the anus Their situation in the loose submucous tissue, where there is but little support, necessarily exposes them to great and sudden variations of pressure before and after defæcation Their dependent position at the lowest part of the portal area, together with the character of their blood-supply, and the fact that they constitute an important communication between the portal and general systems, and thus afford the chief means of escape from a block on the portal trunk—all these reasons may be looked on as **Predisposing Causes** of the con-

dition In addition to these we must also mention a sedentary occupation, alcoholic excess, and chronic constipation, which, by leading to congestion of the liver, are frequent precursors of piles. They are exceedingly common in young people, especially in men about twenty years of age forced to lead a sedentary life, up to middle age the tendency diminishes, but in elderly individuals many conditions, *e.g.*, enlarged prostate, or stone in the bladder, arise which favour their development. Simple stricture of the rectum or malignant disease may so interfere with the return of blood as to determine a development of hæmorrhoids. Young women are remarkably exempt from piles, owing probably to the regularity of the menstrual discharge, but uterine conditions, such as pregnancy, displacements, or tumours, which cause obstruction to the venous return, are liable to be associated with them.

A varicose condition of the veins in the neighbourhood of the anus, is often present without being recognised by the individual, but many different circumstances may bring the symptoms into prominence by causing an attack of thrombosis, such as the use of drastic purgatives, especially aloes, local exposure to damp and cold, as by sitting on a cold wet stone or in a draughty closet, or sudden congestion of the liver, as by alcoholic excess, or a chill.

Two chief varieties of piles are described, *viz.*, the external and internal, but frequently a combination of the two conditions is present.

**External Piles** are found at the margin of the anus, and are covered with skin. They consist of a small central vein in a varicose state, surrounded by a development of subcutaneous fibro cellular tissue, which latter is much more abundant than the vascular element, in fact, they practically consist of longitudinal folds of skin of a dark brown colour radiating from the anus, and superficial to the sphincter. In the usual relaxed state in which they are found they give rise to no Symptoms beyond a little pruritus, and perhaps a sense of fulness and irritation immediately before and after defæcation. They are very liable, however, to become *inflamed* from local irritation or cold, and then appear as tense, bluish, rounded swellings, exceedingly painful and tender, and often preventing the patient from walking or sitting in comfort. In such a state the vein contained in the pile is distended with blood-clot. Under suitable treatment the swelling subsides in a few days, usually leaving the fleshy fold more bulky and harder than previously, owing to the partial or complete organization of the thrombus.

The Treatment of external piles, when uninfamed, is very simple. Constipation must be relieved, the parts should be kept clean and well washed, a hamamelis ointment or extract may be occasionally applied, and great care taken not to irritate the anus after defæcation by the use of hard paper (*e.g.*, newspaper). Very soft curl paper, well crumpled, should be employed, or preferably absorbent wool. It is but rarely that *operative measures* are required in a simple case of external piles, where, however, external and internal piles co-exist,

it is advisable to complete any operation undertaken for the latter condition by the removal of the more prominent fleshy folds surrounding the anus. This is accomplished by grasping them with forceps, and snipping them away by scissors in a direction radiating from the centre of the anus. We would warn the practitioner, however, against too free a use of the scissors, whereby a subsequent contraction of the anus may be induced. For inflamed external piles the patient should be kept in bed, the bowels opened by a copious warm enema, and fomentations applied. If the pain and tension are very great, the tumour should be incised and the clot turned out, the margins of the fold may then be cut away, and the wound dressed.

**Internal Piles** consist of dilated veins held together by a certain amount of connective tissue, and covered by mucous membrane.

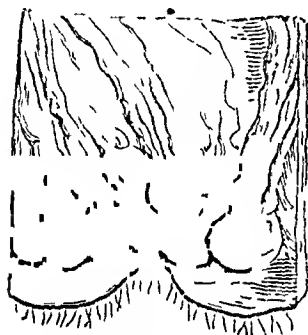


FIG 419.—INTERNAL  
PILES

At first they are quite soft and compressible, and easily emptied on pressure, but when they have existed for some time the connective tissue may be increased in amount, and arterial twigs are often found running into the mass.

The condition is limited to the lower 2 inches of the bowel, and may present very varied appearances in different cases. Thus, there may be a general varicosity of the veins in the submucous tissue without the formation of any distinct tumours. The mucous membrane is then of a deep claret colour, somewhat thickened, and liable to protrude during defæcation. There is a

certain amount of glairy mucous discharge, and the fæces may be streaked with blood, but, as a rule, the hæmorrhage is not great. Such a condition is usually followed by a definite formation of hæmorrhoidal tumours, and not unfrequently runs on to prolapse.

When distinct hæmorrhoidal masses form, they may be of two types. (a) The longitudinal or fleshy pile (Fig 419), consisting of broad sessile masses, dusky in colour, soft and compressible in consistency, and usually covered by mucous membrane, which, although thin and stretched, still remains smooth and shiny, like the skin of a black grape. Between the piles depressions are found, in which small portions of fæces may lodge and produce irritation. This form usually bleeds but little. (b) The globular or bleeding pile is single or multiple, and usually somewhat pedunculated; the surface of the tumour is roughened and granular, like a strawberry, due to the existence of dilated capillaries. When, however, a portion of it has been repeatedly protruded, the exposed mucous membrane becomes hard, and practically converted into skin, and the columnar epithelium may be replaced by the squamous type. The hæmorrhage is often abundant, and comes either from the dilated superficial capillaries, or occasionally from a central arterial twig.

The **Symptoms** arising from internal piles are often not very marked

until hæmorrhage occurs, but there is usually a sense of weight or fulness about the anus, with sometimes pain, which is increased before and after defæcation. The patient feels as if a foreign body were present in the bowel, and the mass not unfrequently protrudes, giving rise to much pain and inconvenience until replaced by the patient, owing to the grip of the sphincter. Sooner or later hæmorrhage is almost certain to be noticed, coming on at first after defæcation, and only a few drops being lost. After a time, however, the flow increases, and may continue to such an extent as to cause marked anæmia. If the case remains untreated, the pain and inconvenience increase, a blood-stained mucous discharge from the rectum is noticed, soiling the linen, reflex irritation of neighbouring organs is produced, and a condition of nerve prostration from pain and hæmorrhage may result. In cases where the piles are due to portal obstruction, as in cirrhosis of the liver, the bleeding may be beneficial, and must not always be checked. Moreover, when the menstrual flow is diminished, a vicarious discharge of blood from the piles is sometimes observed.

**Complications of Piles** — *Inflammation* of the venous ampullæ contained in piles leads to what is popularly termed an 'attack of piles,' although this is much less common with the internal than the external variety, and the fleshy form is that usually affected. Evidences of a localized phlebitis manifest themselves in the shape of a painful distension and swelling of the parts, which become blue in colour and exquisitely sensitive. They subside with or without suppuration, in the latter case a spontaneous cure may result, whilst in the former general blood contamination may follow, death from pyæmia having even occurred. *Strangulation* of the piles by the sphincter ani may follow protrusion where reposition is not effected, the mass then becoming painful, tense, swollen, and livid in colour, inflammation running on to ulceration and even sloughing follows, the patient suffering meanwhile from sickness, pain, and toxæmia. Pyæmia is likely to ensue unless the case is effectively treated, preceded by pylephlebitis (i.e., septic inflammation of the branches of the portal vein in the liver). On the other hand, a spontaneous cure may be effected. *Prolapse* may become chronic, and *fissure* of the anus develop.

The **Diagnosis** of piles from other swellings which occur in the neighbourhood is not difficult. From *prolapse* they are recognised by their irregularity, the swelling not being of a rounded smooth annular variety, as in the former case, the two conditions are, however, often associated. From *polypus* piles are distinguished by being multiple rather than single, by being softer and more compressible, by their situation close to the anus, by the absence of a pedicle, and by the hæmorrhage being usually more marked. *Mistakenly* *internal* *piles* are often mistaken for external piles, but by being symmetrically placed, owing to infection of one lip of the gluteal fold from the other, by their moist surface, and their situation at a little distance from the anus. The

consistency, appearance, and history of an *epithelioma* should effectually prevent any error in diagnosis

It is important also to remember that blood may be passed *per anum* from many other conditions besides piles. In the latter case the blood is of a bright red, florid colour, and often coats the fæces, whereas if it originates higher in the intestinal canal it is dark or tarry in colour (*melæna*), and is more intimately mixed with the excreta. A digital examination of the rectum will also in the latter case eliminate the presence of piles.

The Treatment of internal piles is both general and local

General Treatment consists in removing all possible sources of venous congestion, in regulating the bowels, and assisting the functions of the liver. The latter may be effected by the judicious administration of natural mineral waters, such as Hunyadi Janos and Friedrichshall, or by the use of some such mild aperients as the confections of senna and sulphur, or castor oil. These may be given daily, whilst at the same time the food and drink of the individual are regulated, all excess of alcohol being avoided, and suitable exercise enjoined. In weakly and debilitated individuals it is advisable to adopt a more stimulating and tonic plan of treatment. Aloes should generally be avoided. When dependent on the pressure of a gravid uterus, little can be done beyond attending to the regular action of the bowels until the child is born.

Local Treatment in the earlier stages consists merely in *palliative* measures. Thus the parts must be protected from injury and cold, only soft paper or cotton-wool used after defæcation, and, when protruding, the piles should be sponged with cold water and gently returned. An ointment containing an extract of witch-hazel (*hamamelis*), or the injection of a hazeline lotion (1 in 8), is also advisable, and bleeding from piles can often be arrested by this means. The Ung. gallæ c. opio of the Pharmacopœia is recommended, but is not so efficacious.

When there is much pain or bleeding, and the piles have attained some size, Radical Treatment by operation is necessary. Care must be taken before advising it to ascertain the condition of the liver, as the bleeding may be beneficial in relieving hepatic congestion, and an operation is then injudicious and harmful. In all cases the bowels are thoroughly emptied by a dose of castor oil given the night before and an enema on the morning of the operation, whilst the patient sits over hot water for half an hour beforehand. The lithotomy position is adopted, the perineum is shaved and cleansed, and the surgeon thoroughly stretches the sphincter by introducing the two index fingers and then separating them forcibly, by this means bringing into view the whole of the diseased area of mucous membrane, which never extends beyond 2 inches from the anus. The following plans of treatment are those chiefly used.

1. Removal by clamp and cautery, as introduced by the late Mr Henry Smith. The mucous membrane having been everted, as just described, each of the hæmorrhoidal tumours is grasped by a pair

of ring-ended catch forceps, and thus temporarily secured, by this means the scope of the operation required can be readily gauged. The clamp is then applied to each mass successively in a direction corresponding to the long axis of the gut, great care being taken not to include the external skin. The clamp is tightened by the screw attached to its handle, and the projecting mass of the pile removed by scissors. The cut surface is then thoroughly seared by a cautery at a dull red heat, and the pressure of the clamp slowly relaxed, so as to ascertain that all bleeding has ceased. External piles may be snipped away as indicated above (p 1142), the mucous membrane re-inverted, the parts dusted with iodoform, and a carefully graduated compress of antiseptic wool applied with a T-bandage. The parts are bathed each day with some mild antiseptic lotion, and should be healed in ten to fourteen days. The use of the catheter may be necessary for the first forty-eight hours after a severe case, owing to retention of urine. The bowels are not opened until the fourth or fifth day, and then a good dose of castor oil (*e g*, 1 ounce in adults) should be administered. It is better to allow the patient to sit on a commode for the evacuation of the bowels. From a very large experience of this operation, gained both at hospital and in private, we have no hesitation in maintaining that, if efficiently carried out, and combined with the use of a powerful and properly constructed screw-clamp, it is absolutely safe and free from danger, that any complications from sepsis, hæmorrhage, etc., are due to the carelessness of the surgeon, and not to the character of the operation, and that for all practical purposes it is the best means of dealing with internal piles.

2 *Ligature* is also an operation much in vogue for the treatment of piles, and as now carried out with due antiseptic precautions, a large amount of success attends its use, although it is doubtful whether recovery is as speedy or painless as after the cautery. The hæmorrhoidal tumours are grasped by forceps, the mucous membrane divided around them, and the base ligatured with silk, the mass is then snipped off, and the ligature cut short, the knot being allowed to separate by subsequent ulceration.

3 *Crushing* by means of a powerful clamp has also been recommended by Benham, Allingham, and others, the base of the mass being thoroughly compressed, and the pile then cut away. We think it safer to combine such treatment with the styptic and antiseptic qualities of the cautery.

4 Where the veins of the lower inch or two of the mucous membrane are in a varicose condition, but no definite hæmorrhoidal tumours are present, *Whitehead's operation* may be employed. It consists in the total removal of this pile-bearing area in the same way as for excision of the rectum. An incision is made round the margin of the anus at the junction of the skin and mucous membrane, and the latter dissected up from the muscular coat of the bowel by successive snips of the scissors, it is then cut away, all bleeding-points are secured, and the lower end of the divided mucous mem-

brane united by suture to the skin, the stitches passing deeply under the surface of the wound and not merely through the margins. Excellent results have followed such treatment in suitable cases.

### Rectal Prolapse

A certain tendency to eversion of the mucous membrane of the bowel is a constant and normal accompaniment of the act of defæcation, if, however, this becomes abnormally increased, the condition may be maintained after the evacuation of the bowels is concluded, constituting a condition of prolapse. At first only the mucous membrane is protruded, and this is known as an *incomplete* prolapse, if, however, the condition persists, the whole thickness of the bowel may become involved, mucous membrane, submucosa, and even the muscular and serous coats, giving rise to the *complete* variety (Fig 420). The former condition (sometimes badly termed a prolapsus ani) is more commonly met with in adults, and the latter (the so called prolapsus recti) in children, but it must be understood that the latter is always preceded by an incomplete stage, limited to the mucous membrane, and that in adults complete prolapse is occasionally observed.

**Causes**—1 It may be produced by a simple relaxation of the tissues, as met with in weakly individuals, and those who have been much exposed to the debilitating effects of residence in tropical climates, especially when chronic constipation or diarrhœa has caused the evacuation of the bowels to be accompanied by straining efforts. 2 Conditions which have led to chronic tenesmus or violent expulsive efforts, *e.g.*, piles, chronic constipation, diarrhœa, rectal irritation, as from worms in children, or diseases of neighbouring organs, such as vesical calculus, stricture, or enlarged prostate, may also determine prolapse.

**Symptoms and Diagnosis**—The anal orifice is occupied by a smooth rounded swelling, red or purplish in colour, covered by mucous membrane, this protrusion in the early stages can be easily replaced by a little pressure, but returns if the patient strains or coughs. When the swelling is of large size, reduction is increasingly difficult and painful from infiltration and fibrous overgrowth of the submucosa, and it is very liable to become inflamed and ulcerated from friction. Incontinence of fæces is also a common result. When the whole thickness of the gut is protruded, the serous lining may accompany the tumour, but this is usually limited to the anterior surface, and into the sac thus formed small intestine or omentum may pass, and even become strangulated (Fig 420, X). The prolapse itself may also be constricted if allowed to remain for long unreduced, the mass is then livid, swollen, and intensely painful, and if left to itself may slough away, and thus lead to a spontaneous cure, although severe septic symptoms may supervene, and even perforative peritonitis.

There should be but little difficulty in recognising a prolapse, the only condition for which it can be mistaken is an intussusception pro

truding from the anus, in such, however, the finger or a probe can be inserted into the rectum by the side of the protruding gut, which is impossible with a prolapse

**Treatment**—In the earlier stages, all that is needed is the removal, if possible, of the cause of the tenesmus, *e g*, dilatation of a urethral stricture, removal of a vesical calculus, or the regulation of the bowels so as to check either chronic diarrhoea or constipation. When piles are present, they should be treated as described above, and the prolapse will, as a rule, subsequently disappear. Thread-worms must be dealt with by suitable means (*q v*). Beyond this, cold or astringent injections may be employed, *e g*, sulphate of iron (1 to 3 grains to 1 ounce), and it is advisable for the individual to acquire the habit of having the daily motion at bedtime, whilst children are made to defæcate lying on the side, one buttock being pulled up for the purpose. The prolapse is carefully washed, reduced by pressure with the fingers, and retained by strapping the nates together, particularly in children, or by applying some suitable pad and a T-bandage. The chief factor in obtaining a cure in this way consists in never allowing the prolapse to remain unreduced for any length of time.

When such palliative measures fail, **Operative Treatment** must be undertaken.

In the slighter cases of incomplete prolapse, it will suffice to diminish the size of the anal orifice by snipping away radiating folds of skin and mucous membrane, and allowing the wounds thus produced to cicatrize. In the worse cases it may be necessary, in addition, to remove strips of the mucous membrane in a longitudinal direction by means of the clamp and cautery, or a larger area of the posterior wall of the prolapse may be denuded of its mucous covering, and the edges brought together by deep stitches. Where such has failed, or is thought undesirable, the prolapse may be dissected away by incising the circumference of the anal orifice at the junction of the skin and mucous membrane, and turning down the outer layer of the mucous coat like a cuff. A finger inserted in the bowel suffices to draw down all the slack inner lining, and to ascertain that nothing is present but the mucous membrane. The whole of the prolapsed portion is removed by scissors, all bleeding points being secured as divided, the upper edge of the mucous membrane is then united by suture to the cutaneous margin of the anal orifice.

In cases of total prolapse of the bowel in children, nothing but

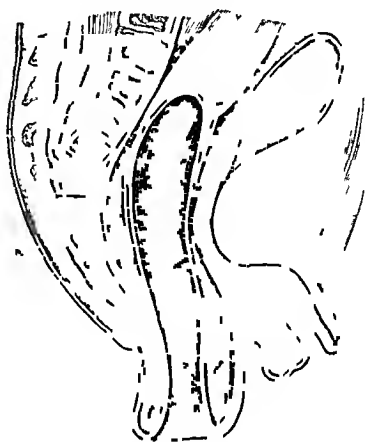


FIG. 420.—LONGITUDINAL SECTION OF COMPLETE PROLAPUS RECTI (TILLMANN'S)

× indicates the serous sac in the anterior wall due to protrusion of the peritoneum



palliative treatment is generally necessary, but in adults a modification of the above-described operation is required. The patient's buttocks are well raised, so as to prevent any protrusion of intestine if the peritoneal cavity is opened. The base of the prolapse is divided anteriorly on a level with the anus, the opening in the peritoneum temporarily packed with sterilized gauze, and the remainder of the mass removed by scissors, bleeding points being secured as divided. The serous cavity is then carefully closed by sutures, and the divided end of the bowel united to the skin at the anus. No motion is allowed to pass for a week, but the anal orifice and lower gut should be thoroughly washed out twice or thrice daily to prevent accumulation of septic material. Control over the bowel is usually regained, though often somewhat slowly, and the after-treatment is likely to be prolonged.

In bad cases the prolapse often recurs after operation, and it is then desirable to cut down on the sigmoid flexure from the groin and anchor it by sutures to the abdominal wall (*colopexy*). Not unfrequently prolapse of the uterus accompanies the rectal lesion, and then a median incision should be made, and the uterus fixed to the anterior abdominal wall (*hysteropexy*), and the rectum sutured either to the back of the uterus or to the abdominal parietes.

## CHAPTER XXXVIII

### SURGICAL AFFECTIONS OF THE KIDNEYS

THE kidneys are placed on either side of the middle line, and extend from the 11th rib above to midway between the last rib and the iliac crest below, the right kidney being somewhat lower than the left owing to the presence of the liver. The hilum is situated opposite the spinous process of the first lumbar vertebra, and the upper ends of the organs are nearer to the spine than the lower.

Manual examination of the kidney is made with the patient lying on the back, with the legs raised and the head supported by a pillow, the mouth is left open. The surgeon, kneeling or standing at the side of the couch, places one hand under the loin and presses it upwards, whilst the other is gently but firmly pressed backwards in the lumbar region, especially during expiratory movements. Unnatural enlargement or displacement downwards of the organ will be thereby detected, as also irregularities in outline or modification of tension.

An enlarged kidney is recognised by the following general characters. A swelling is noticed in the loin, which is shaped more or less like the kidney, a notch being occasionally, though rarely, felt on the inner border, and the outer margin being rounded. The flank is always dull on percussion, the note remaining unaltered whatever the patient's position, and intestine never finding its way behind the tumour. The passage of the colon in front of the kidney not unfrequently gives rise to a band of resonance over its anterior surface, the bowel, however, soon gets pushed aside by the growth of the tumour. On the right side it is not unusual for the renal dulness to be continuous with that due to the liver. The mass moves slightly on respiration, though less distinctly than the liver or spleen, and no pedicle can be felt passing down towards the pelvis.

On the left side it has to be distinguished from an enlarged spleen, the latter viscus hugs the anterior abdominal wall, and has no gut in front of it, whilst the loin is usually resonant.

It is not uncommon, however, to find cases where physical examination of this type reveals but little, and although one may suspect the kidneys of being the cause of some modification of the urinary secretion—*e.g.*, hæmaturia or pyuria—it may be difficult to be certain as

to the origin of the blood or pus, or as to which kidney it is derived from. Again, it is essential to make certain as to the existence and functional value of the second kidney before an organ which is apparently diseased beyond hope of repair is removed. Many different methods have been suggested, but most of them are unsatisfactory. (i) The mere detection of a kidney by *palpation* is worth nothing, as though of normal size its functional value may be nil. (ii) *Open exploration* through a lumbar or abdominal incision is more satisfactory, as the condition of the renal vessels and of the ureter can also be ascertained. It involves, however, an operative measure of some gravity. (iii) *Catheterization of the ureters* is a satisfactory method of procedure, but has two disadvantages. In the first place, it is difficult

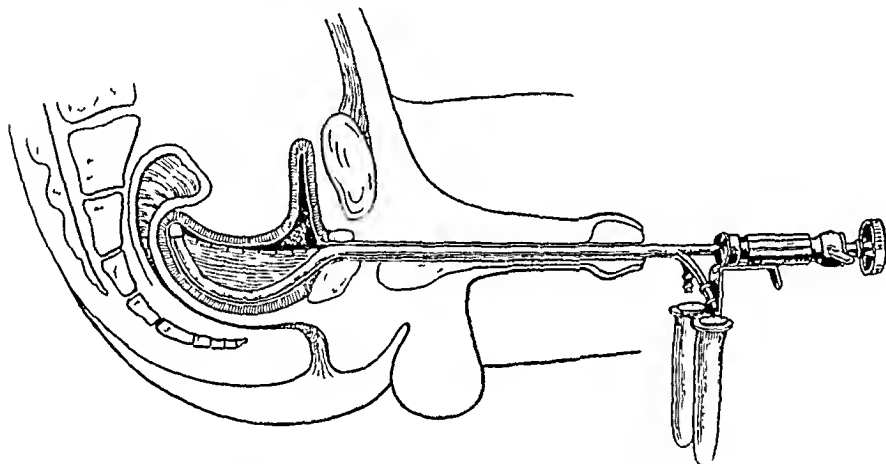


FIG. 421.—LUIS' SEGREGATOR IN POSITION FOR COLLECTING SEPARATELY THE URINE ESCAPING FROM THE TWO URETERS.

The indiarubber septum can be seen stretching across the bladder cavity and the curved beak fits down firmly into the bas fond of the bladder so that the urine will at once pass into the opening on either side of the septum, and so up to the collecting glasses. The screw-head of the instrument controls the septum which is, of course, only stretched into position after the introduction of the instrument.

to effect, and certainly in the male requires special instruments and considerable practice, whilst, in the second place, the ureter may be infected by the catheter, which has to pass through the bladder, which is often in a state of inflammation. (iv) The first of these objections also holds good in connection with the idea of temporarily clamping the lower end of the ureters, or rather of the fold of mucous membrane extending from the orifice towards the trigone. By this plan the secretion of each kidney in turn can be obtained. (v) The most satisfactory method consists in the use of one of the *segregators* or separators, several types of which are now in the market. Luis' segregator (Fig. 421) acts very efficiently. The bladder is first thoroughly irrigated, and the instrument introduced. The indiarubber septum is then drawn up into place, and the urine collected from

the two sides as it enters the bladder. To act effectively the curved end must be pressed well backwards against the posterior vesical wall.

The kidneys may be exposed by two chief routes, viz., the lumbar and the abdominal.

The **Lumbar incision** (Fig 422, B) commences at a point corresponding to the outer border of the erector spinæ, and 1 inch below the last rib, extending downwards and outwards in the direction of the fibres of the external oblique towards the anterior superior iliac spine. The posterior portions of the abdominal muscles and the fascia lumborum are divided *seriatim*, and the fatty tissue surrounding the kidney is thus easily reached and opened.

The **Abdominal incision** is made along the *linea semilunaris*, which is divided, and the peritoneal cavity opened. If the colon lies over the kidney, it is displaced inwards and held aside, as also the other intestines, by cloths soaked in warm salt solution, the peritoneum covering the posterior abdominal wall is incised to the outer side of the colon, and the organ thus exposed. When, however, the kidney is large, it is often unnecessary to open the peritoneal cavity, the colon and other peritoneal contents being displaced inwards.

A third method has been advocated by some surgeons, known as the **Lateral or Lumboabdominal**. The incision extends vertically from the tip of the last rib to the iliac crest, and, if necessary, a cross-cut is made backwards at right angles to it. The peritoneum is stripped forwards from the kidney, the operation being thus retroperitoneal. The advantage over the ordinary lumbar incision has, however, yet to be demonstrated.

**Congenital Affections of the Kidney**—Many different malformations and displacements are met with affecting this organ.

The chief Malformations are as follow: (a) Complete absence of one organ, a very rare condition, and (b) congenital atrophy of one kidney, it being represented by a mass of fatty tissue, in both cases the other organ is correspondingly enlarged and hypertrophied. (c) The kidneys may be fused together, either constituting one large organ in the median line, and more or less normal in shape, or sometimes constituting the so-called horseshoe shaped variety, the convexity being directed downwards. (d) Deep lobulation of the kidney, as in some animals, is sometimes seen, especially if the organ is displaced, occasionally this is carried to such an extent as to divide it into two or more portions. (e) The ureter and pelvis may be double, this malformation affecting the pelvis

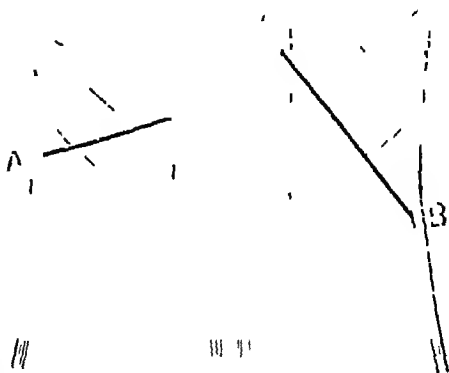


FIG 422 —DIAGRAM TO ILLUSTRATE LUMBAR INCISIONS

A, For lumbar colotomy, B, for exposing the kidney

alone, or extending as far as the bladder (f) The renal artery may arise from the aorta in two or more main branches

The majority of these malformations are of very little clinical importance, except in the operation of nephrectomy, when they may necessitate some modification of the usual proceedings

**Congenital Displacement of the Kidney** occurs about once in every thousand individuals, the organ being either depressed, so as to lie over the sacro-iliac synchondrosis or sacral promontory, or raised above its normal position. The left kidney is more frequently affected in this way than the right, and, when lying in the iliac fossa, the descending colon is usually displaced inwards, so that the rectum starts to the right of the middle line. The adrenal bodies retain their normal position, and do not move with the kidney

Cystic disease, sarcoma, and hydronephrosis may also occur congenitally, and will in turn be described below

**Floating and Moveable Kidney** — The normal kidney is not a fixed organ but moves up and down on respiration, although usually such movement cannot be detected on palpation. It is therefore necessary to define as precisely as possible what is meant clinically by the terms 'moveable' and 'floating' kidney. Three stages of abnormal mobility may be described. (i) A *palpable* kidney is one the lower half or more of which can be definitely felt on deep inspiration. (ii) A *moveable* kidney is one in which the examining hand can define the upper end of the organ, and can restrain it from returning to its old position during expiration. (iii) A *floating* kidney is one which can be moved freely about the abdomen in all directions, and even across the middle line in some cases. Formerly this last term was applied to a supposed congenital lesion, in which the kidney was attached to the posterior abdominal wall by means of a mesentery, it is more than doubtful whether such a condition exists

In the earlier stages the movements occur within the fatty capsule which surrounds the organ, but later on mild attacks of inflammation attach the fatty to the fibrous capsule, and the kidney with its associated fatty envelope moves behind the peritoneum. Two forms of movement are possible. (i) An up and-down or in-and-out movement in one plane (*cumder-sifting* movement), the kidney merely swinging on its pedicle, or (ii) a movement of torsion may accompany this, either round a transverse axis when the lower end of the kidney becomes prominent, or round a vertical axis when the outer convex border swings forwards. In the latter case kinking of the ureter or renal vessels is very likely to ensue

Moveable kidney occurs more frequently in women than in men (10 to 1), and more often on the right than on the left side (12 or 13 to 1), partly because the renal vessels are longer on this side than on the other, and partly because the descending colon is more fixed than the ascending

**Causes** — The kidney is normally kept in position by a firm packing of fat between the layers of the perinephric fascia, but in addition the tension of the peritoneum, the maintenance of the intra-abdominal pressure, and the support of the muscular abdominal parietes, have much to do in keeping it in place. Anything that seriously modifies

these three factors may lead to displacement and mobility of the organ. Parturition accounts for many cases, firstly, because of the sudden diminution of the intra-abdominal pressure, and, secondly, owing to the resulting pendulous and relaxed state of the abdominal muscles, especially if the patient too early resumes the erect posture, or undertakes physical work without efficient external support; hence it is more frequent among the poor than amongst the rich. It may also follow the removal of large abdominal tumours which stretch the abdominal walls, or rapid emaciation, whereby the perinephric fat is absorbed, whilst tight-lacing or traumatic influences may be responsible for some cases. It is frequently associated with that form of displacement downwards of the abdominal viscera which is known as Glenard's disease, or enteroptosis.

**Symptoms**—A moveable kidney is often discovered by accident, and is entirely free from symptoms. In some cases the patient comes under observation because she has observed a moveable lump in the abdomen, which on handling is painful, the pain being often associated with nausea and vomiting. In other cases the pain and vomiting bring the patient under observation, the doctor discovering the moveable kidney. The pain is referred to the back, or perhaps shoots along the ureter to the groin, testis, or labium majus. Vomiting is a significant sign, and the surgeon should never omit to examine the loins in cases of obstinate vomiting with no apparent cause. Periodical exacerbations of these symptoms, with a temporary diminution in the amount of urine, result from kinking of the ureter (*Dietl's crises*), sudden relief, followed by an increased flow of urine possibly containing some muco-pus, indicates that the organ has returned to its normal situation. Repeated attacks of this type may result in pyelitis and hydronephrosis. On examining the abdomen, a moveable tumour can often be observed with ease if the abdominal parietes are not loaded with fat, and on manipulation pain and vomiting may be induced. The adoption of the genu pectoral position will sometimes enable a moveable kidney to be more certainly felt, whilst a distinct loss of resistance is noticed external to the erector spinæ on the affected side.

The patient is almost always very neurotic, and evidence of the displacement of other abdominal viscera is often found, so that the detection of a moveable kidney does not necessarily explain the whole case, or indicate operation. Many a patient has been operated on for moveable kidney, but the symptoms (pain, vomiting, etc.) persisted, even when the organ remained anchored to the abdominal wall.

**Treatment**—It must be fully recognised that in the great majority of cases in which unnatural mobility of the kidney can be detected operation is not required. Only when it can be definitely established that the kidney is the real source of the symptoms should operation be considered, and even then it may be possible to deal with it by other means. Pressure will sometimes restrain the mobility of the organ, and this is best applied by means of an air cushion incorporated in an abdominal belt, the cushion should be triangular, its sides corresponding to the costal border, Poupart's ligament, and the

linea semilunaris, it is put on in the recumbent posture, and for choice with the pelvis raised. If prior to the use of this appliance the patient will submit to a stay in bed, with a course of abdominal massage and Swedish exercises, and be fed up well, so much the better.

If, however, the organ is so tender that the needful pressure cannot be borne, or if evidences of hydronephrosis or pyelitis are present, or if the kidney is extremely mobile and handling causes vomiting, etc., then operation may be wisely recommended, and in suitable cases does much good. *Nephronaphy* or *Nephropexy* is the name applied to this procedure. It is obvious that a rounded structure like the kidney with a smooth fibrous capsule is not easily fixed, and the more so since the renal parenchyma has great absorbent power, so that sutures, even of silk, passed through its substance are early disintegrated and absorbed, hence, although the kidney may seem to be efficiently immobilized at the completion of the operation, it readily becomes loose again. There are only two certain methods of fixing the organ. (1) The wound down to the kidney is left open and packed with gauze so that healing occurs by granulation, the cure is certain, but tedious, whilst a lumbar hernia may follow. (2) The plan now usually adopted is to expose the organ by the lumbar incision. The fatty covering is opened, and as much of it as possible removed. A portion of the true fibrous capsule is now dissected up and fixed to the abdominal parietes so as to expose the raw and slightly bleeding cortex. Many methods of dealing with the capsule have been suggested, but it matters little which is employed. Personally, we prefer to strip up a good sized flap from the centre of the organ and fix it by stitches between the divided muscles, whilst a deep suture is passed through muscles and kidney above and below the bared area. The organ is thus firmly fixed, but it is wise to keep the patient in bed for four or five weeks subsequently to allow of consolidation, and afterwards a binder or belt should be worn for a time.

Injuries of the Kidney are usually due to crushes of the body, as between the buffers of railway cars, or when a cart passes over the abdomen, or from blows or falls. Considerable hæmorrhage follows, both into the substance of the kidney or its pelvis, and into the perinephric fatty tissue, and this even when the capsule has not been torn. The integrity of this structure is a point of great importance, since it limits to some extent the bleeding and prevents urinary extravasation, the kidney may be crushed to a pulp without any external hæmorrhage, and under these circumstances clots are likely to pass down the ureter, and may obstruct it and lead to its subsequent occlusion. When the anterior portion of the capsule is torn, the peritoneum may also be involved, especially in children, and then evidences of intra peritoneal bleeding may manifest themselves, and, indeed, if the kidney is extensively lacerated, fatal hæmorrhage may result, though this is unusual. Rupture of the posterior surface of the kidney opens up the retro peritoneal cellular tissue which becomes infiltrated with blood and urine, and suppuration is almost certain to follow, resulting in pyæmia or at a later date in exhaustion from

chronic septic poisoning Not unfrequently other severe injuries are present, such as fracture of the pelvis, spine, or skull, bruising or tearing of intestine or liver, and from these associated lesions serious phenomena may arise

The **Symptoms** consist in severe shock, followed by nausea, vomiting, pain in the loin, shooting down into the testis or thigh, localized tenderness and perhaps swelling over the injured organ, and hæmaturia The amount of blood lost in this way varies considerably, in the slighter cases the hæmaturia is of short duration, but in more extensive lesions it may be severe and so persistent as to threaten life The passage of clots down the ureter gives rise to renal colic, and obstruction of that duct may lead to total suppression of the secretion on the affected side The bladder may in some cases become greatly distended with clots, the blood coagulating after it has entered the viscus Hæmorrhage into the perinephric tissues is indicated by the formation of a swelling in the loin, and laceration of the peritoneum is followed by distension of the abdomen, increasing anæmia from persisting hæmorrhage, and the onset of peritonitis The development of a perinephritic abscess is recognised by fever, rigors, increased pain in the loin, and the usual phenomena of deep supuration (p 1162)

The **Treatment** usually required is to keep the patient quiet in bed, with an icebag or Leiter's tubes applied to the loin, pain may be relieved by strapping the side or by applying a firm bandage. Persistent hæmorrhage necessitates the administration of ergot, tannic acid, or turpentine, but if it is threatening the patient's life, an exploratory incision is required, and, if need be, removal of the organ, although it is sometimes possible to stitch up a limited rent, the sutures being passed deeply through the organ Any distension of the bladder must be relieved, the clots being washed out through a large-eyed catheter The occurrence of peritonitis or of a perinephritic abscess will call for suitable surgical measures, the injured viscus being dealt with according to its condition

**Rupture of the Ureter** is a rare accident, usually due to direct violence, but occasionally happening during pelvic operations, such as removal of the uterus When due to a subcutaneous injury, it cannot be recognised at once, but extravasation of urine takes place, resulting in the formation of a perinephritic abscess This is incised sooner or later, and on exploring the cavity it may be possible to detect the rent in the ureter, but more frequently its situation cannot be found, and then a doubt will necessarily exist as to whether the lesion involves the ureter or the pelvis of the kidney In either case a urinary fistula in the loin results, which may possibly close after a time, if the fistula persists, nephrectomy will be required, and then the sooner such an operation is undertaken the better In a few favourable cases it has been possible to suture the rent in the ureter by the following plan The lower end of the divided ureter is closed, the exposed mucous membrane being tucked in by sutures passing through the muscular coat, the upper end is then implanted into a longitudinal



opening made in the side of the lower segment, and accurately stitched in position

Two cases probably of this nature came under treatment at hospital. Both occurred in young boys, and both were due to cab accidents. In the first, after the preliminary shock had passed off, nothing special was noted for about ten days, when on sitting up sharp pain was experienced in the side, and this was followed by a retro-peritoneal collection of fluid, together with some amount of fever. On incision a large quantity of limpid urine escaped, with but very little pus—an interesting illustration of the fact that healthy urine does comparatively rarely pass into issues into which it is extravasated. The finger introduced into the cavity, but the rent could not be found. Drainage was provided, and for a time a urinary fistula persisted, finally, the wound healed completely. In the second case the inflammatory phenomena were more marked, but an incision was not made until the twelfth day, here also the lesion could not be found, and drainage was resorted to, but without avail, nephrectomy being subsequently required. Both cases recovered.

**Hydronephrosis** is a condition characterized by distension of the pelvis and calyces with urine, as a result of some obstruction to its exit.

**Causes**—(1) It may be *congenital* in origin. It must be borne in mind that the body of the kidney is developed from the metanephros, and that the ureter unites subsequently with it to form its excretory duct, such union is occasionally defective at the upper end, well-marked obstruction occurring at the junction of the ureter with the infundibulum of the pelvis. Similar trouble sometimes arises from the ureter becoming kinked over an abnormally-placed renal artery. It is, however, more frequently due to an impervious condition of the urethra or to the existence of a membranous septum therein, both kidneys are then necessarily affected. The amount of distension in some of these cases is such as to interfere seriously with parturition until the abdomen has been tapped. The infants are often born dead, or succumb shortly after birth. (2) *Acquired* forms of obstruction are by no means uncommon, and may be arranged under the following headings: (a) Blocks within the urinary passages from the presence of stones, parasites, foreign bodies, or even blood-clot, (b) changes of structure affecting the walls of the urinary passages, e.g., inflammatory swelling of the mucosa, cicatrices, stenosis, or tumours, (c) kinking of the ureter in cases of floating kidney, and (d) the pressure of extrinsic tumours or cicatrices, as after pelvic cellulitis. Hydronephrosis may be unilateral or bilateral, in the former case the obstruction arises within the ureter, or from some vesical condition involving its entrance into the bladder, in the latter case the cause is generally to be looked for below this spot.

It must be clearly understood that a sudden and absolute block never leads to hydronephrosis. Should it occur as the result of impaction of a calculus in one of the ureters or of ligature of the ureter, as has occurred in hysterectomy, the secretion on that side is totally suppressed as soon as the tension within the pelvis and calyces is sufficiently high. Atrophy of the renal epithelium follows after a time, but if the obstruction is relieved within six weeks of its incidence, the secretion of urine will probably be re-established. Should,

however, the obstruction be intermittent or incomplete, so that some of the urine escapes, thereby relieving the pressure, hydronephrosis develops. Sudden and complete occlusion of the urethra likewise results in dilatation of the bladder and rupture either of that viscus or of the urethra, whilst a gradually increasing obstruction is always likely to lead to hydronephrosis.

**Pathological History**—The earliest result of obstruction to the flow of urine consists in dilatation of the ureter and pelvis, which is soon followed by expansion of the calyces. The pyramids are flattened, and the cortex expanded and thinned, so that the whole kidney looks larger than usual. A certain amount of interstitial infiltration of the cortex is always present, the urine secreted in the early stages is usually abundant and of a low specific gravity.

If the obstruction continues, the renal tissue becomes more and more atrophied, until finally it disappears entirely, the kidney being represented by a thin walled multilocular cyst. At any stage septic phenomena may supervene, giving rise to pyonephrosis (*vide infra*).

The **Clinical History** varies considerably with the method of onset and the cause of the trouble. Frequently all that happens is a painless enlargement of the affected organ, if both are involved, there may be at first some increase in the amount of urine secreted, which is pale, limpid, and of a low specific gravity, after a time the quantity diminishes, and finally anuria and uræmia follow, especially if septic changes supervene, as is so commonly the case. When only one kidney is affected, the excretion may remain normal in quantity and quality, owing to compensatory hypertrophy of its fellow. Not unfrequently a fluctuating swelling of considerable size is produced by hydronephrosis, it presents all the physical signs of a renal tumour (p 1149), and its formation is often associated with pain, vomiting, and increased frequency of micturition. Finally, a perinephritic abscess may develop, owing to ulceration of the pelvis or ureter, and the cyst may thus discharge through the loin. Occasionally the size of the tumour varies considerably from time to time, owing to the obstruction being temporarily overcome by the pressure of retained urine behind it.

The **Treatment** of hydronephrosis should in the first place be directed to removal of the cause, if practicable, and where the

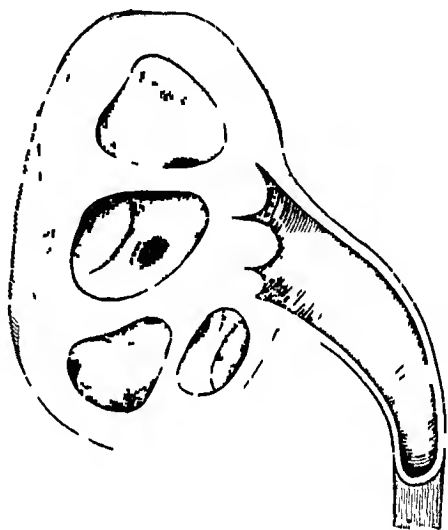


FIG 423 — HYDRONEPHROSIS (FROM SPECIMEN IN BRISTOL HOSPITAL MUSEUM)

obstruction exists in the prostate or urethra, no other treatment is feasible. In some cases of congenital hydronephrosis due to malformation of the upper end of the ureter, it is possible to transplant it and thereby relieve the obstruction. Unilateral hydronephrosis must be dealt with by aspiration as a temporary measure, but this is rarely satisfactory, and usually needs to be followed by an exploratory incision (nephrotomy), by means of which it may be possible in a few cases to reach and deal with the obstruction. In the majority, however, the block is situated so low down that it cannot be reached, and nephrectomy must then be undertaken.

**Nephritis**, or inflammation of the kidney, is an affection which occurs in many different conditions, and is suitably discussed in medical text-books. The presence of albuminuria is of considerable significance to surgeons, and in all cases demanding surgical interference the urine should be carefully tested. It will be further discussed at p. 1198.

In addition, we must note that surgical interference has been utilized in cases of chronic Bright's disease. Edebohl\* of New York and others have completely removed the capsule of both kidneys in some of these patients, and the results obtained have been very encouraging. The technique is simple and needs no special description, but the operation is often difficult in fat œdematous subjects. It is claimed that the operation is most suitable to young people with post-scarlatinal chronic nephritis, and may save life in suppression of urine following catheterism or exposure to cold. The further history of this procedure will be watched with much interest.

**Pyogenic Infections of the Kidney and Ureter** may develop from many distinct sources, and give rise to several allied, though distinguishable, clinical conditions. Thus, (i) the infective material may reach the kidney from the blood in the shape of emboli, as in pyæmia, causing a diffuse inflammation of the renal substance with a development of many scattered abscesses (*acute suppurative interstitial nephritis*), or of one larger abscess. Sometimes a focus of disease pre-exists in the kidney, e.g., stone, tubercle, or cancer, and the superadded infection adds much to the gravity of the symptoms. (ii) When once the kidney substance is involved, the trouble is only too likely to spread to the pelvis, causing a suppurative *pyelitis* (or inasmuch as the renal parenchyma is already invaded, a suppurative *pyelonephritis*), and thence the mischief spreads down the ureter, and may perhaps infect the lower urinary passages, constituting a condition of *descending pyelonephritis*. (iii) A common method of origin consists in pyogenic organisms spreading upwards from the bladder to the ureter and kidney. This is seen frequently in the affection which used to be termed 'surgical kidney,' and followed in the train of so many diseases accompanied with cystitis, e.g., stricture of the urethra, enlarged prostate, stone in the bladder, etc. It will be remembered that the ureter passes through the bladder in an oblique direction, and is guarded by strong sphincteric muscular fibres, and thereby the

\* *Medical Record*, March 28 1903

spread of infection upwards is rendered more difficult. It is probable, however, that the mucous membrane lining the orifice becomes itself inflamed, and a small plug of mucus develops within it, through which the germs are able to pass upwards. In other cases they certainly find their way *via* the lymphatics of the mucous membrane, which are continuous in the ureter and bladder. When the phenomena caused by this infection from below are limited to a suppurative condition, it is known as an *ascending pyelonephritis*, but if to them is added an element of distension, due to the cause being of an obstructive type, then the distended suppurating kidney is known as a *pyonephrosis* (iv). Sometimes the infection reaches the urinary passages from neighbouring organs, though this is certainly uncommon. We have known an appendix abscess to open through the kidney and discharge itself, or to involve the ureteral wall.

The organisms usually present are staphylococci, streptococci, or the *B. coli*, which, as we shall see later on, is constantly associated with inflammation of the bladder.

1 **Pyelitis** is the term applied to an inflammation involving the pelvis of the kidney, the calyces, and perhaps the ureter. The chief causes from which it arises are (a) The presence of a calculus, or the passage of uric acid crystals in gouty individuals, (b) tuberculous disease, either starting primarily in the kidney, or extending upwards from the bladder, (c) extension of septic inflammation from the bladder and urethra, (d) malignant disease of the kidney, (e) occasionally in floating or moveable kidney, (f) the ingestion of irritating drugs, e.g., cantharides, turpentine, and even cubebs or copaiba, (g) the presence of foreign bodies, such as needles, bullets, and parasites, e.g., the *Bilharzia hematobia* or the *Strongylus gigas*, (h) a pyæmic embolus, and (i) possibly cold. In the milder cases and in the early stages it may be a simple catarrhal inflammation, but it is almost certain to become of a purulent type if it lasts long.

Whatever the cause, the pathological phenomena are the same, consisting in the lining membrane becoming congested and thickened, and secreting a muco-purulent, or even purulent, discharge. Owing to the swelling of the mucous membrane, the entrance to the ureter is encroached on, and a certain amount of distension of the pelvis and calyces (hydronephrosis) follows. Where micro-organisms are present, as in cases due to extension from the bladder, the kidney is likely to be involved in the process (pyelonephritis), or the condition may be followed by a urinary abscess in the loin or suppurative perinephritis.

The **Symptoms** of pyelitis consist of pain and tenderness over the affected kidney, increased frequency of micturition, and the *intermittent* discharge of pus in *acid* urine. The intermissions are due to the inflammatory swelling of the mucous membrane, which temporarily blocks the upper entrance to the ureter, and necessitates a certain degree of pressure of the urine and pus accumulated in the pelvis of the kidney in order to overcome the obstruction. Necessarily, where pyelitis follows chronic cystitis, the acid reaction of the

urine is neutralized by the changes occurring in the bladder, in such cases a nocturnal elevation of temperature is usually noted

The **Treatment** of pyelitis is mainly directed to the cause. Where such is removeable, *e g*, calculus or foreign bodies, an operation is advisable. In the ascending type, which originates in the bladder, treatment should first be directed towards the latter viscus. In the simple catarrhal variety the patient is kept warm, his diet restricted to bland fluids, and urotropine, alkalies, and sedatives prescribed. If these measures fail and the condition becomes painful and purulent, the presence of a stone may be suspected, and a radiographic examination should be made, or the affected kidney should be explored.

2 **Pyelonephritis**, or inflammation of the pelvis of the kidney together with the renal parenchyma, is almost invariably suppurative in type, and either due to extension upwards from the lower urinary organs, or to a local lesion of pelvis or kidney, such as calculus or tuberculous disease.

In almost all cases of pyelitis a certain degree of renal congestion is present, but when the condition becomes confirmed, and especially when septic matter is present in the calyces, it is certain to light up a subacute interstitial nephritis. In the later stages bacteria invade the pyramids and travel upwards along the lymphatics or renal tubules, giving rise to abscesses, either scattered through the connective tissue of the organ or within its tubules, in either case seriously damaging its excretory function. In both instances it is possible for many of these minute foci of pus to run together and form a large collection, which in time becomes recognisable from outside, but more usually the patient dies of toxæmia or uræmia before that stage is reached. When the affection ascends from the bladder, it may commence suddenly and with acute symptoms, and then probably results from some surgical operation or simply from catheterism in a patient whose bladder is in a highly septic condition. The organisms find their way upwards along the lymphatics in the mucous lining of the ureters, and soon infect the pelvis, the walls of the ureters may in such cases be studded with miliary abscesses.

The **Clinical History** of pyelonephritis is a little vague. In *acute* cases the symptoms probably commence with a severe rigor shortly after the operation which has called the trouble into existence. This is associated with pain in the loins or back, headache, vomiting, great thirst, and probably some amount of drowsiness, perhaps passing into a condition of coma. The rigor may be repeated, or the fever may remain high without exacerbations, but if uræmia is present or threatening, the temperature may be subnormal. The urine is usually diminished in amount, and, indeed, may be suppressed entirely, if any passes, it is high-coloured and contains albumen and perhaps blood, with some amount of pus, which is probably derived largely from the lower portion of the urinary track. The prognosis in these cases is nearly hopeless, the patient being almost certain to die of uræmia, especially as both kidneys are generally affected, although in the more chronic type, if the cause of obstruction is removed, he may recover.

In the more *chronic* cases, the symptoms correspond to those of a pyonephrosis (*qv*), which condition is almost certain to be present. Granting that the cause can be removed or satisfactorily dealt with, recovery is quite possible in these cases, but the kidney is, of course, permanently damaged, and some degree of sclerosis is certain to follow.

**Treatment**—In the *chronic* variety, the cause must be efficiently dealt with, if possible, but the surgeon must not forget that an acute attack may be easily lighted up by injudicious instrumentation or operations. Hence it is desirable to drain and wash out the bladder, as by a perineal cystotomy, rather than to dilate or divide a stricture of the urethra. An enlarged prostate or calculus must be removed, but it may be desirable to wash out or drain the bladder for a few days before undertaking such operations, so as to diminish the risks of sepsis. The patient is kept quiet and warm in bed, and is encouraged to drink plenty of bland fluids. In the *acute* form, the essential element of treatment is to prevent the development of uræmia, and to diminish the congestion of the kidney and re-establish the efficient secretion of urine. The patient is kept warm in bed, and is given plenty of bland fluid, such as milk and barley-water, stimulants are avoided, as also opium. Hot-air baths, wet packs, and the hypodermic injection of pilocarpine, will suffice to get the skin to act well, and watery purgatives, such as jalap and scammony, are needed for the bowels. The loins are cupped or fomented, and it is an open question whether the kidneys should not be exposed and their capsules removed, so as to diminish tension.

3 **Pyonephrosis** is the term applied to indicate the association of a chronic pyelonephritis with distension of the pelvis and ureter, as a result of obstruction to the passage of urine. When unilateral, it is commonly due to the presence of a calculus, or of tuberculous disease, the obstruction being due to the swelling of the ureteral mucous membrane, if the affection is secondary to obstruction in the lower urinary passages, it is usually bilateral. The lining membrane of the pelvis is inflamed, thickened, and perhaps ulcerated, decomposing urine and pus collect in the dilated pelvis and calyces, and a soft, friable, phosphatic calculus may develop in consequence, even in cases where the originating cause is not of a calculous nature. Obstruction to the outlet may lead to such an accumulation of pus as to constitute an abscess of the kidney, whilst a certain amount of perinephritis is always present.

**Clinical Signs**—The kidney is found to be enlarged and tender on palpation, whilst more or less constant pain is present in the loin. The temperature is usually somewhat raised, especially at night, from the absorption of septic products, the patient steadily loses ground, and becomes emaciated, the tongue is dry, the appetite diminished, and nausea and vomiting are sometimes present. The urine is usually scanty in amount, and loaded with muco-pus, which may be constant or intermittent. If both kidneys are involved, the excretion of urine gradually diminishes, leading to a fatal issue from uræmia, unless the patient dies previously from toxæmia or pyæmia.

**Treatment** — Where both kidneys are involved as a result of some urethral or prostatic affection, no special treatment directed to the kidneys is feasible, but if the condition is unilateral, and not secondary to disease of the lower urinary organs, nephrotomy should be undertaken, and any removeable cause dealt with. Failing this, the cavity may be drained, or even nephrectomy performed.

4 **Abscess in the Kidney** may follow any of the conditions already alluded to, in which bacteria gain access to the organ from below. It also occurs in connection with pyæmia and after the general infective fevers, being then more or less of a pyæmic type. In acute interstitial nephritis the abscesses are multiple and at first small, being located between the tubules or sometimes within them, the pyramids then have a streaky-white appearance due to their infiltration with pus, and the abscesses form in the cortical substance at their base. Larger collections are caused by the amalgamation of several of the smaller. In pyæmia the abscesses are preceded by infarcts, which appear immediately beneath the capsule as wedge-shaped areas of a chocolate colour, which turns to yellowish white as suppuration occurs. Symptoms are not produced unless the abscess is large enough to be detected from outside, the mere presence of pus in the urine associated with an enlarged and tender kidney is not sufficient evidence of abscess formation. When the collection is large enough, the organ can be distinctly felt, and perhaps fluctuation detected. The abscess may burst into the pelvis and discharge through the ureter, but when due to an ascending pyelonephritis from obstruction this is not likely to be the case. The inflammation is more liable to spread outwards through the kidney substance, and give rise to a suppurative perinephritis. Treatment of an abscess of the kidney consists in nephrotomy for drainage purposes, or perhaps nephrectomy.

The more chronic varieties are probably tuberculous in origin, and may then attain considerable dimensions, all that is noted being the lumbar swelling, whilst pyuria is not necessarily present, owing to the ureter becoming blocked.

5 **Perinephritis** cannot be recognised unless suppurative in nature, resulting either from septic wounds or from ulceration involving the walls of the pelvis and calyces, or from the transmission of micro-organisms from the interior of a suppurating kidney or pelvis without any breach of surface. A perinephritic abscess may also arise from inflammation spreading from the intestine, appendix, pleural cavity, ribs, or elsewhere.

The **Symptoms** may be acute or chronic in nature. In *acute perinephritis*, signs of deep suppuration in the loin are produced, viz., an indurated painful swelling, associated with fever, and perhaps preceded by rigors. The body is held stiff and rigid, with an inclination towards the affected side. Fluctuation may sometimes be detected when pus has formed, but the abscess is often so deeply placed that it is difficult to recognise it at first, it is likely to point at the side of the erector spinæ, or may burrow forwards between the abdominal muscles, and find an exit on the anterior abdominal wall. Occa-

sionally it bursts into the peritoneal or pleural cavities, or into the intestine. If it comes to the surface, it is preceded by congestion and œdema of the skin. *Chronic perinephritis* gives rise to no characteristic symptoms until an abscess forms which is large enough to be felt. Sometimes it is of a simple type, and does not suppurate, but the kidney becomes adherent to surrounding parts, and to such an extent as to render nephrectomy difficult and dangerous.

**Treatment** in the suppurating variety consists in giving exit to the pus through an incision at the outer border of the erector spinæ, the cavity is then carefully examined, and the cause of the supuration, if possible, determined, and treated according to the requisites of the case.

**Tuberculous Disease of the Kidney** occurs in one of three forms. (a) It may arise in the course of acute general tuberculosis, when miliary tubercles are found studding the organs, but giving rise to no special symptoms. The patient is usually a child. Treatment, of course, is impracticable.

(b) It may extend upwards from a similar affection of the bladder, and then almost invariably involves both kidneys. The mucous membrane of the ureter becomes thickened and transformed into œdematous granulation tissue containing tubercles, and that of the

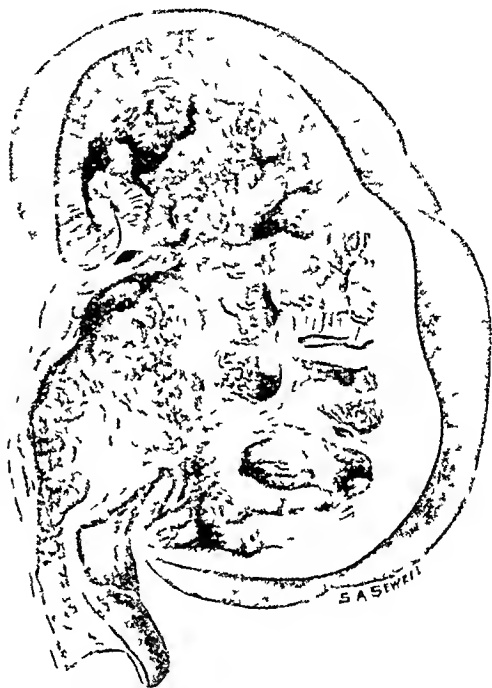


FIG. 424.—TUBERCULOUS KIDNEY, SHOWING THICKENING OF MUCOUS MEMBRANE OF PELVIS AND URETER (FROM SPECIMEN IN COLLEGE OF SURGEONS' MUSEUM)

pelvis and calyces is similarly affected, finally, the renal parenchyma itself becomes infiltrated with tuberculous tissue spreading from the pyramids. The patients are usually young adult males, and their liability is explained by the frequency of genital tuberculosis. *Clinically*, enlargement of both kidneys is noticed, arising partly from the deposit of tubercle within the organ and partly from obstruction within the ureter. The symptoms caused by the renal mischief cannot at first be distinguished from those due to the vesical trouble. Perinephritic abscess occasionally follows, and the patient dies from exhaustion, septic absorption, or uræmia. Treatment in these cases is of no avail.

(c) **Primary Tuberculosis** of the kidney is generally unilateral, and



commences as a deposit of tubercle in the cortex or at the base of one of the pyramids. A caseous mass forms, which may extend widely, causing disintegration of the kidney substance, or may burst into the pelvis and infect that cavity. A tuberculous pyonephrosis follows, and the process spreads for some distance down the ureter, and even infects the bladder (Fig 424). Suppurative perinephritis may also supervene, and give rise to an abscess which bursts externally.

The **Symptoms** are at first indefinite. The patient is usually a young adult, and rather more frequently a male than a female. He complains of increased frequency of micturition, and unilateral pain in the loin, neither of which conditions is improved by rest, remaining the same at night as in the day. The pain is generally of an aching character, and more or less constant, although exacerbations may occur. The urine is acid, and usually contains a certain proportion of pus, in which on examination the *B. tuberculosis* can often be detected. Hæmaturia is not marked, even if present at all. On examination the kidney may be found to be slightly enlarged, but is not tender, except in the later stages, when it constitutes a tumour of considerable size, and may contain a large quantity of pus, and even a phosphatic concretion. Loss of flesh, night sweats, and a nocturnal rise of temperature, are present in the later stages.

The **Diagnosis** of primary renal tuberculosis is usually a matter of doubt, if the presence of bacilli in the urine cannot be demonstrated, since the symptoms are very similar to those of renal calculus. The history of the patient and of his family may be of importance, and he should be carefully examined for evidences of tuberculous disease elsewhere, especially in the genital organs. The chief points of distinction are that the symptoms are less influenced by exercise or rest, and there is less hæmaturia or renal colic than when a calculus is present, whilst the kidney is usually not so tender on manipulation, of course, the condition is much less common than that of stone. In doubtful cases the final distinction is made by exploring the organ through an incision in the loin. The tuberculous kidney is usually mottled in colour and pallid-looking, whilst hard, scattered, caseous nodules may be felt, which become fluid on pressure, or on incision give exit to caseous pus. The upper part of the ureter is often somewhat thickened and indurated. In calculus the surface is uniformly even and dark red, or if any areas of softening are present, they are of a bluish-red colour, the pelvis and upper end of the ureter are usually lax and distended. If the disease has extended sufficiently to cause a thickening and induration of the ureter which can be detected on rectal or vaginal examination, the diagnosis is rendered almost certain.

**Treatment** — If on exploration of the kidney the disease is found to be strictly limited and the pelvis unaffected, it may be possible to treat it in the same way as tuberculous affections elsewhere, viz, by scraping away the diseased tissue, careful purification of the

cavity by liquefied carbolic acid, and plugging the wound thus formed. In other cases it may be possible to excise wedge-shaped areas of the renal cortex, securing the wounds by sutures. In the majority of instances, however, the disease will have spread much too extensively for such conservative treatment, the kidney practically consisting of a series of cysts filled with offensive pus. If the surgeon is tolerably certain that the other kidney is healthy, nephrectomy should be performed, care being taken to divide the ureter below the farthest limit of the disease. The occurrence of a perinephritic abscess necessitates an incision in the loin, and through this opening the kidney can be explored and, if necessary, removed.

**Renal Calculus**—**Renal Calculi** are usually met with in individuals suffering from lithiasis, as indicated by the passage of sand or gravel in the urine. The general causes of this condition are detailed elsewhere (p 1195). All

renal concretions are primarily excreted in a crystalline form from the renal tubules, but under ordinary circumstances are sufficiently small to find their way into the pelvis of the kidney, and thence along the ureter to the bladder. If, however, they are obstructed in their onward course, either on account of their size or shape, or some narrowing of the tubules, they may become lodged in the kidney substance or in one of the calyces, and by the gradual deposit of the same material increase in size



FIG 425 —CALCULOUS KIDNEY (COLLEGE OF SURGEONS' MUSEUM)

until large enough to give rise to symptoms (Fig 425). Renal calculi are usually not of great bulk, rarely exceeding that of a Barcelona nut, occasionally, however, the whole of the pelvis, and some of the calyces, may be occupied by a concretion, which takes the shape of the cavity in which it lies. When many calculi are present in the pelvis of the same kidney, they are usually faceted. Chemically they consist either of uric acid or urate of ammonium, sometimes however, they are composed of oxalate or acid phosphate of lime.

The **Pathological Phenomena** connected with renal calculi vary with their size, shape, number, and position. If situated in the substance of the renal parenchyma, they give rise to but little change, being more or less encapsuled in a cavity lined by granulation tissue.

When occupying the pelvis of the kidney, they set up pyelitis, and from the obstruction to the flow of urine, caused partly by the thickening of the mucous membrane, and partly by the calculus engaging the orifice of the ureter, produce dilatation of the pelvis of the kidney, and the phenomena of hydro- or pyo-nephrosis. If on account of their shape or size they become imprisoned in one of the calyces, ulceration of the wall and suppurative perinephritis may follow, the calculus may even find its way into the abscess cavity, and be discharged spontaneously or removed through the loin, a urinary fistula often resulting. If the calculus passes down the ureter, it gives rise to the symptoms of renal colic. When small and smooth, it usually reaches the bladder without much difficulty, and is then voided with the urine, or remains as a vesical calculus. Occasionally, owing to its size or irregular shape, it becomes impacted in the ureter, usually at its upper end, giving rise to acute obstruction and the cessation of the urinary secretion on that side, followed in time by disorganization. If the kidney thus affected is the only one available for excretory purposes, or if both ureters are similarly obstructed, the patient, if unrelieved, dies in a few days from suppression of urine (*calculous anuria*). In other cases the stone ulcerates through the wall of the ureter, giving rise to a retro-peritoneal urinary abscess, or possibly to suppurative peritonitis. If the ureter is only partially obstructed by the calculus, the changes which take place in the kidney are more gradual, and result in hydro- or pyo-nephrosis.

The typical **Symptoms** arising from renal calculus are as follows. The patient complains of pain in the loin, more or less persistent, and often paroxysmal in nature, which is, however, always increased on exercise or jolting, it is frequently referred to distant regions, but most commonly follows the course of the genito-crural nerve, giving rise to pain in front of the thigh, accompanied by retraction of the testicle, in the female it is also experienced in the labium majus. Sometimes it extends down the back of the thigh, and it has even been said that pain in the heel is pathognomonic! It is almost invariably associated with hæmaturia, and often with pyuria, the amount of blood or pus being increased on exertion. Frequency of micturition is a prominent symptom, whilst if the pelvis is enlarged the kidney may be tender and distinctly palpable. If the calculus is lodged in the renal parenchyma, the urinary secretion may be but little influenced, although the characteristic pain is well marked, the patient also finds that at night he can only gain relief by lying on the affected side, and on manual examination the kidney, though somewhat tender, is not much enlarged. When the calculus lies in the pelvis or one of the calyces, the typical phenomena described above are produced, but it is then noticed that at night the patient lies on the sound side, since the organ is both enlarged and tender. On the other hand, it is an undoubted fact that stones even of large size may exist for years in the kidney without giving rise to any symptoms whatever.

The passage of a calculus down the ureter is accompanied by the symptoms known as Renal Colic. They consist of excruciating pain of a paroxysmal nature, which comes on suddenly, and is referred both to the loin and along the course of the genito-crural nerve. It is always associated with vomiting and severe shock, the patient often lying on the floor writhing in agony, with cold perspiration standing in beads on his forehead. The temperature is subnormal, and the pulse weak and rapid. Strangury is usually present, the patient suffering from frequent paroxysmal efforts to pass water, but only succeeding in evacuating a small amount, and that generally blood stained. After lasting for a variable period, the pain suddenly ceases, as a result of the passage of the calculus into the bladder, or of its slipping back into the pelvis of the kidney.

Impaction in the Ureter may occur either just below the pelvis of the kidney, or near the brim of the pelvis, or near the vesical orifice. In thin persons it has been detected on palpation through the abdominal wall, and when low down has been felt on rectal or vaginal examination. Persistent pain and hæmaturia extending over days or weeks should certainly suggest the presence of a ureteral calculus, and the more so if with each attack the pain and tenderness are located lower down. Rectal examination may confirm this by the detection of a shadow below the usual level of a renal calculus, particularly if the kidney is not specially enlarged. The result may be that the stone will ulcerate through into the retro-peritoneal tissue, and be discharged in an abscess, or more frequently the kidney is disorganised, and perhaps the patient's life destroyed through the resulting renal incompetence.

Calculus anuria is the term applied to a cessation of the urinary secretion which follows the blocking of one or both ureters with calculi, the opposite kidney in the former case being absent, atrophied, or diseased. The condition is usually lighted up by some physical effort, which presumably dislodges the calculus. It is ushered in by sudden pain in the loin, which often passes away in the course of two or three days. The anuria is rarely complete at first, a few ounces of pale limpid urine being passed at intervals, whilst occasionally distinct polyuria is present. Sooner or later definite uræmic phenomena supervene, the most usual period is seven or eight days after the onset, but incomplete obstruction or a pre-existing condition of hydronephrosis may delay matters. The onset of uræmia is indicated by persistent vomiting, a slow, full pulse becoming irregular, contraction of the pupils and muscular tremors. Coma and convulsions are rarely seen, and there is no dyspnoea, the temperature is subnormal.

The Diagnosis of renal calculus is often a matter of uncertainty in the absence of a history of the passage of gravel or of the occurrence of renal colic. It is most likely to be mistaken for tuberculous disease, the differential diagnosis between the two conditions has already been considered (p 1164). The final determination of the presence or not of a renal or ureteral calculus is now usually made

by skiagraphy, which has made such advances that it may be relied on with almost absolute certainty. We are indebted to Mr A D Reid, radiographer to King's College Hospital, for the following account of his methods and results

The apparatus employed at King's College Hospital for exciting the tube consists of a 10-inch variable primary coil, worked from the 100-volt continuous

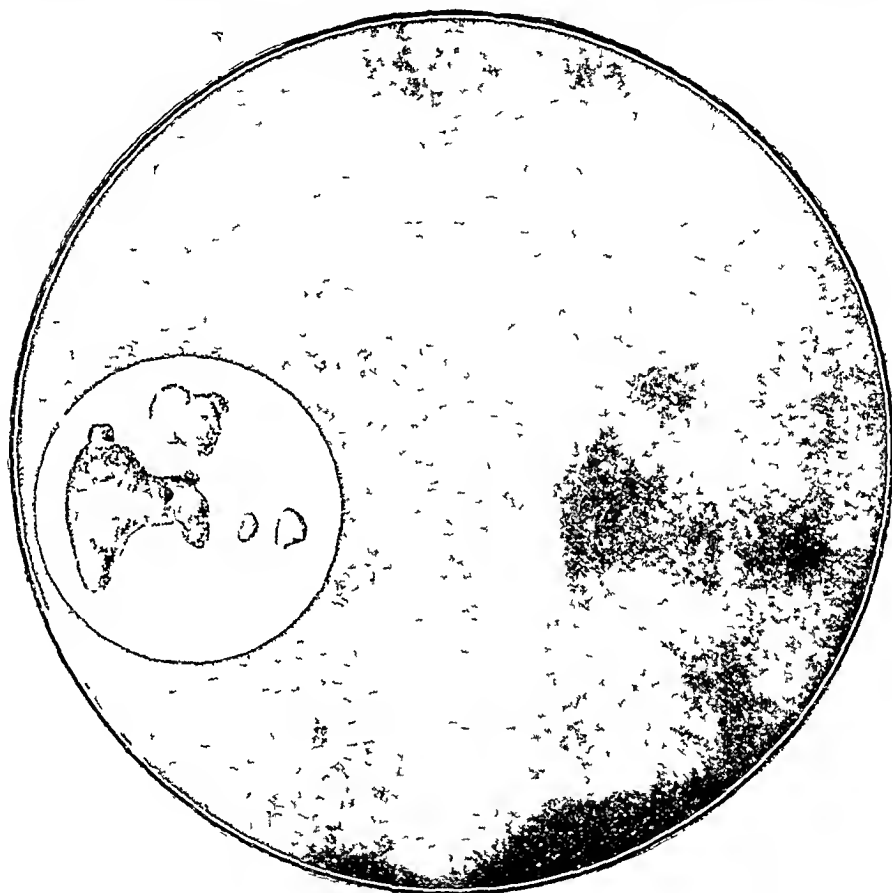


FIG 426 —SKIAGRAM OF RENAL CALCULI (MR A D REID)

In the negative four shadows are seen corresponding in position and shape to the four stones which were removed. Much has been lost in reproduction, but the shadows can still be seen. The actual calculi removed by operation and drawn relatively to size are seen in the smaller circle.

main with an electrolytic interrupter. The tube, a heavy anode regulator (Muller), is enclosed in a box with lead-glass or thick plate-glass sides, but open at the ends, enabling one thereby to regulate it easily. The top of the box is rendered opaque to the rays by lining it with a layer of red lead and a thick sheet of rubber, and a circular hole 3 or 4 inches in diameter is cut in such a position that the anode forms the centre of this circle. Above this is fixed an iris diaphragm with leaves of thick brass, which gives any aperture from 1 to 4 inches, and which can be altered by a slight movement of a vulcanite arm

attached to its outer ring. This box is placed on a platform on the sub-stage of a canvas-topped couch, and by means of this sub-stage the box can be moved longitudinally or transversely.

*Preparation of Patient*—It is extremely important that the patient's bowels should be as empty as possible when the skiagrams are taken, in order that no

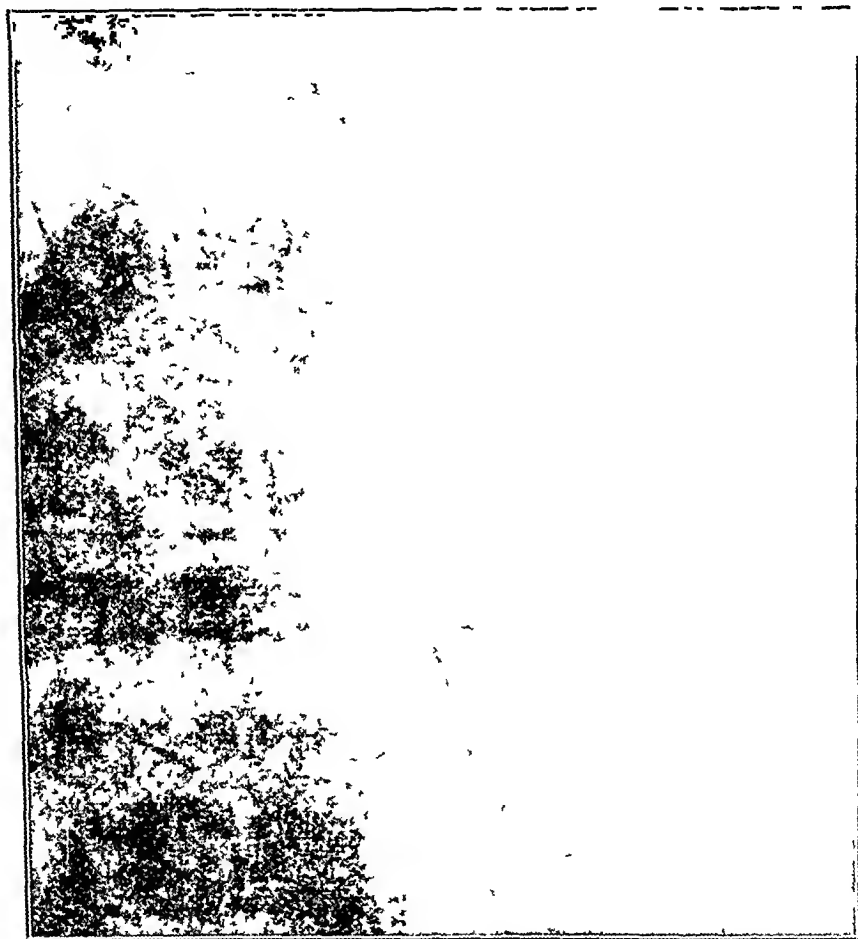


FIG 427—SKIAGRAM OF CALCULUS IN URETER (MR A D REID)

The patient was a young lady, and the diagnosis was confirmed by operation, the calculus was a rough concretion of acid phosphate of lime. (N.B.—The outline of this calculus has been a little strengthened to ensure its satisfactory reproduction. With one other exception (viz., Plate XXV) it is the only skiagram which has been 'touched up' in the entire series published in this book.)

shadows should be thrown on the plate by fecal material in the large intestine which might superpose the kidney shadow and be mistaken for a calculus. The routine treatment is to keep the patient on light diet and a saline aperient for two days previous to taking the skiagrams. The night before a purgative is given consisting of 15 grains each of Pulv jalape and Pulv scammonii, and on the morning an enema is administered through a long tube, no meal is allowed before the skiagram is taken.

*Technique of taking Skiagram*—The patient is placed on his abdomen on the couch, and a cylindrical air-cushion made of thin rubber, 6 inches in diameter and 2 feet 6 inches long, inserted underneath him between the lower ribs and the iliac crests. This serves a double purpose, in compressing the abdominal contents, and also making the back flat, so that the plate will lie in accurate apposition thereto in its full extent. The tube-box is then arranged with the diaphragm wide open, and the whole area examined with the screen. It is generally possible to see a renal calculus of some size on the screen, and the shadow will be seen to move up and down with respiration a distance of from 1 to 1½ inches.

This fact—namely, the wide excursion of the kidney during respiration—though well known, has not been sufficiently insisted upon with regard to skiagraphy for calculus, and it is the omission to restrain respiration during the process that has largely contributed to the inaccurate results that have been sometimes obtained.

Having examined the whole area with the screen with the large diaphragm, it is well to use a small one, and examine each area separately, and if nothing can be seen, to take the skiagrams.

Three skiagrams are generally taken, the first with a 3-inch diaphragm, using a 10 by 12 plate, with the tube centred under the spine, taking in both kidneys and ureters, and the other two on 10 by 8 plates, the tube being centred under each side, using the smallest diaphragm that will include the whole kidney. In all cases the anode of the tube is as nearly as possible 20 inches from the plate.

The plate is enclosed in two light-tight bags and placed film downwards on the back, and kept there either by placing a weight on it or by strapping. The patient is directed to take several long breaths, and then to hold his breath in the position of full inspiration. This phase of respiration is chosen because it brings the upper end of the kidney down, and gets it clear of the ribs as far as possible, and also because the patient is thereby able to keep still longer than in expiration.

An exposure of five to thirty seconds, varying with the size of the patient, is then given at a current of 15 ampères through the primary of the coil. In most cases it will be possible to get the desired exposure in a single inspiration. In a case where this is not possible, the same result can be obtained by divided exposures, which are made for shorter periods with a rest between each, the current only being allowed to pass through the tube when the patient is in the position of full inspiration. To do this the operator, holding the commutator or a cut-out in his hand, should fix his head so that his eyes are on a level with the plate, and mark a chalk line on the opposite wall, which will just coincide with the line of the plate on the patient's back at full inspiration, and thus he can be quite sure of getting his exposures all at the same phase of respiration.

In some cases it is well to make another exposure during expiration, the use of which was well shown in one case where at inspiration the shadow of a small stone coincided exactly with the end of the last rib, and would have been missed but for the evidence of the second plate.

In all cases control photos should be taken under the same conditions two days later.

*Results*—During the last two years 150 cases have been skiagraphed for possible calculus in kidney, ureter, or bladder, and of these 63 have been subsequently operated on.

A positive skiagraphic result was given in 36 cases—25 in the kidney, 3 in the ureter, and 8 in the bladder. Of the 25 renal cases, the stone was found by the surgeon in 23, in 1 it was found post-mortem, and in 1 case it was missed, being merely a small collection of sandy material. Of the 3 ureteral calculi, 2 were found at operation, and the third passed subsequently. In the 8 vesical cases the stone was found and removed in 7 instances.

A negative skiagraphic result was followed by operation in 12 renal cases and 15 vesical, and of these a stone was found once in the kidney and once in the bladder.

**Treatment**—In the early stages treatment is directed to the cure of lithiasis (see p 1195) The patient's diet and general habits of life must be suitably regulated, and he is instructed to make use of alkaline waters, such as those derived from Contrexéville or Vichy, or citrate of lithia and sulphate of soda may be administered in a mixture. Plenty of bland fluid should be ordered, such as boiled or distilled water, in the hope of dissolving the stone or assisting its onward passage to the bladder. Sometimes it may become encysted, if the patient is kept absolutely at rest, the symptoms will then gradually ameliorate, and finally disappear.

Attacks of renal colic are treated by the use of hot hip-baths, warm drinks, and hypodermic injections of morphia, in the more severe cases chloroform must be administered.

In former days, when the presence of a calculus could only be suspected from the history or symptoms, the question of operation and when to undertake it was a subject of much discussion. Even in these days Mr Henry Morris wrote that 'an unsuspected renal calculus is a source of very real danger, and when its presence is disclosed, whether by accident or by the systematic examination of the urine, we should recommend its immediate removal, regardless of the fact that it is not causing pain, unless the general condition of the patient contra-indicates an operation'. At the present time, when radiography has placed in our hands a means of almost certain diagnosis, the same advice holds good—whenever a stone is found, remove it, unless special contra indications exist. Especially is this the case when a considerable amount of blood or pus is being passed in the urine, and the patient's temperature is raised. Pain in both kidneys is no contra-indication to operation, since there is no objection to exposing and even removing calculi from both organs. The constant passage of gravel, moreover, need not deter one from operating, since when once the kidney has been relieved by removal of the larger masses, the tendency to recurrence may be checked by suitable diet or drugs.

**Nephro lithotomy** is always undertaken through the loin. When exposed, the kidney is carefully freed from its connections, and drawn up into the wound, in the majority of patients it can be brought out on the loin, and this is certainly a desirable manœuvre. The whole gland is then carefully palpated, as also the pelvis and upper part of the ureter, so as to locate, if possible, the stone. Should it be distinctly felt within the kidney substance, an incision is made through the renal parenchyma over it, free hæmorrhage follows, but this is readily controlled by inserting the finger into the wound, or by grasping the vessels in the hilum. Should the stone not be palpable, an incision is made through the convex border of the kidney substance, a little posterior to the mesial plane of the organ and at the junction of its inferior and middle thirds. One of the lower calyces is opened by this means, and the interior of the pelvis is carefully and fully explored by finger and probe. Sometimes the incision in the kidney has to be considerably enlarged and the discovery of a small calculus



may be a task of great difficulty. When the pelvis is much distended and the patient has previously passed a good deal of pus, extra precautions must be taken to protect the surrounding tissues from infection. Sterile gauze is packed into the angles of the wound, and the assistant must press up the abdominal wall. The incision still passes through the cortex in preference to opening directly into the pelvis, a pelvic incision heals with difficulty, and is liable to leave a fistula. Stones are removed by dressing-forceps or scoop, and care must be exercised to prevent any from falling backwards into the ureter. Large branched calculi are often held very tightly, and require an extensive incision and careful peeling off of the kidney substance. The pelvic cavity need not be irrigated under ordinary circumstances, but when dilated and suppurating it is well to do so with a hot solution of sublimate or of Condy's fluid. Before closing the wound in the kidney the ureter should be carefully examined, it is sometimes possible to introduce a ureteral sound through the open wound, but this is by no means easy, and it is often wiser to make a tiny opening through the pelvic infundibulum, through which the sound is passed, and which is subsequently sutured by a Lembert's stitch. Bleeding is usually controlled without difficulty by sutures passed through the kidney substance, to which in bad cases may be superadded pressure by sponge or a gauze plug in the wound. It is useless to attempt to place a ligature on a vessel divided in the renal parenchyma. It is usually wise to introduce a drainage-tube down to the sutured wound in the kidney, after it has been replaced. The abdominal parietes may then be closed in the usual way.

A ureteral calculus may be reached by prolonging the lumbar incision downwards and forwards in a direction parallel with Poupart's ligament towards the inguinal canal (the lumbo-ilio-inguinal incision of Henry Morris). The peritoneum and its contents are pushed bodily inwards, and the ureter attached to the posterior peritoneal wall can be followed down to within a few inches of the bladder. A stone is removed through a longitudinal incision, which is subsequently closed by Lembert's stitches. A calculus impacted close to the bladder has been removed through the rectum or vagina, or by a trans-sacral operation.

Where the organ is totally disorganized nephrectomy may be required, but such treatment is not always advisable, especially when sinuses have resulted from a suppurative perinephritis. In such cases the renal tissue has often entirely disappeared, and disintegrating calculous material may occupy the pelvis, which is surrounded by a mass of dense fibro-cicatricial tissue, the removal of which is impracticable and even dangerous. All that should be attempted is the extraction of the stone and the purification of the cavity, the patient must resign himself to the inconvenience of a suppurating sinus in the loin.

**Tumours of the Kidney**—The different forms of tumour which originate in the kidney may be classified as the *simple* and the *malignant*. Several cystic conditions also occur. The general features of an enlarged kidney have been already described (p 1149).

The Simple tumours of the kidney are

1 **Diffuse Cystic Disease** (or, as it has been termed, adenoma of the kidney), which may be congenital or acquired. It is not unfrequently bilateral, especially when congenital. The kidney is enlarged and occupied by cysts, varying in size, but rarely exceeding that of a cherry; they are lined with epithelium, which is generally flattened, and filled with a limpid fluid containing urea and perhaps cholesterine. The cysts are often very numerous, and may project from the surface of the kidney as nodular elastic outgrowths.

The pelvis remains unaffected until the later stages of the disease (Fig 428). Generally the whole kidney is involved, and may attain enormous dimensions, but occasionally the growth is limited to one portion of the organ. The origin of this condition is uncertain, but it is supposed to be due to the persistence of the mesonephros (or Wolffian body) in the substance of the true kidney (or metanephros), and its development into cysts. The early symptoms are simply those of pressure, but at a later stage the secretion of urine is interfered with to such an extent as to produce uræmia. The tendency of this affection to affect both kidneys prevents any hope of benefit from operation.

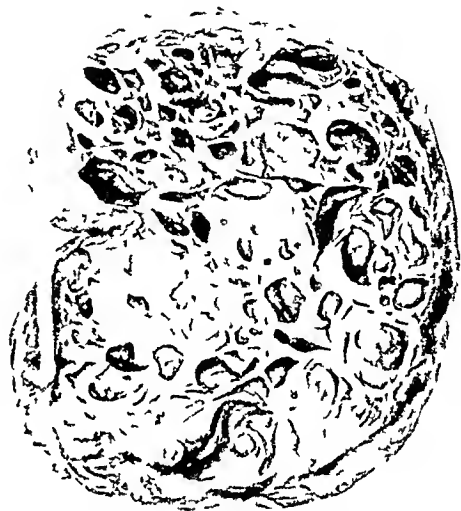


FIG 428 —CYSTIC DISEASE OF KIDNEY  
(KING'S COLLEGE HOSPITAL MUSEUM)

2 **Papilloma** of the renal pelvis is a rare condition, characterized by the development within its cavity of a villous mass, identical in structure with that met with in the bladder. It has usually been observed in elderly people, and the chief, if not the only, symptom is excessive hæmaturia. It cannot be diagnosed with certainty, but if found in an exploratory operation, it can be removed with success.

3 Occasionally tumours of a considerable size are found growing from the kidney, similar in structure to the zona fasciculata of the adrenal bodies. They are looked on as adenomata growing from accessory and misplaced adrenals; the renal parenchyma is normal in texture, though stretched over the new growth. They may remain small for a time, but when once they begin to grow their increase in size is rapid, and they must be looked on as semi-malignant. When diagnosed, they may be removed together with the kidney, and the results are usually satisfactory.

Malignant tumours of the kidney may be divided into

1 The **Sarcomata of Infants**, which are often congenital, but may

be acquired within the first few years of life. They are encapsuled, the kidney substance being sometimes spread over them, and consist of round or spindle cells, the latter often showing a cross-striation, resembling that of muscular fibres (*myo sarcomata*). They grow to a great size, and may affect both organs, but pain and hæmaturia are absent. Death results from general dissemination or from exhaustion, or may follow mechanical obstruction to the circulation, as by the detachment of a sarcomatous embolus, which travels upwards and blocks the pulmonary vessels. **Treatment** by nephrectomy has given most unsatisfactory results, the operative mortality having been high and recurrence almost invariable within a short period. The operation itself is not particularly difficult, but a large incision is required, and care must be taken to avoid displaced structures, such as the inferior vena cava. When both kidneys are affected, nothing can be done.

2 The ~~Sarcomata of Adults~~ occur between the thirtieth and fiftieth years of life, and are of the spindle-celled variety. Only one kidney is generally involved, giving rise to a rapidly growing swelling, associated with pain and hæmaturia. Calculi are often found in the pelvis of such organs. Secondary deposits form in the viscera, extension through and beyond the capsule is not uncommon, and death is usually due to exhaustion. The results of nephrectomy have not been very encouraging.

3 **Carcinoma** is an uncommon form of tumour in the kidney. It presents the same clinical features as a sarcoma, and can only be recognised on microscopic examination. One symptom, however, requires special mention, since it is extremely suggestive of the presence of cancer, viz., the development of a *varicocele*. It is due to the pressure of enlarged and cancerous lymphatic glands upon the roots of the spermatic veins, and hence, whenever an elderly person develops a varicocele, a careful examination of the kidney on the affected side should always be instituted.

Various **Cystic Conditions** of the kidney must be noted in addition to the general cystic disease, already described.

(a) **Hydatid Disease** affects the kidney, as it may involve any other organ in the body. It starts either beneath the capsule or in the glandular substance, in the former case it is likely to form a rounded projection, which may be detected on palpation of the loin, in the latter it expands, or even destroys, the whole of the glandular tissue, and may burst into the renal pelvis, the cysts being passed along the ureter, accompanied by more or less colic. Suppuration may complicate matters, but, unless the cyst has ruptured into the pelvis, diagnosis is scarcely feasible apart from an exploratory incision.

**Treatment** consists in cutting down on the kidney, and enucleating the mass, if possible. Failing this, drainage may be undertaken, but in bad cases nephrectomy is necessary.

(b) **Dermoid Cysts** have also been found.

(c) **Serous Cysts** are occasionally met with, arising possibly as a result of obstruction to some of the ducts. Rounded swellings, single

or multiple, are produced, growing outwards from the cortex, and containing a thin fluid with a small amount of albumen and saline substances in solution. They give rise to no symptoms except from their size, and rarely require treatment other than simple aspiration or drainage.

(d) Not unfrequently a number of small cysts develop in connection with chronic granular nephritis, but they are of no clinical importance.

**Nephrectomy**, or total removal of the kidney, is performed for the following conditions: (a) For tuberculous disease, when conservative measures are impracticable, or when the pelvis and ureter are involved, (b) for calculous pyonephrosis, when the renal parenchyma is disintegrated, (c) for hydronephrosis, when palliative measures or drainage have failed to give relief, (d) for malignant disease, (e) for traumatic lesions, such as disintegration or rupture, especially if complicated by laceration of the peritoneum, and (f) for some cases of ruptured ureter.

Before undertaking the excision of any kidney, however diseased, it is essential that the surgeon should satisfy himself as to the existence of another, and also, if possible, ascertain that it is capable of undertaking the increased duties which will subsequently fall upon it. Many different plans of doing this have been already alluded to (p 1150).

Nephrectomy may be undertaken through the abdomen or through the loin, but sundry combinations or modifications of these operations have been recommended by various authorities.

The *Abdominal Operation* is chiefly utilized when the organ is much enlarged, on account of the readier access obtained, especially to the pedicle. The main objection lies in the fact that the peritoneum is opened, and thereby exposed to septic contamination, especially when the pelvis and the upper part of the ureter are distended with decomposing pus, as is frequently the case. Moreover, no satisfactory drainage is obtained for the cavity left by the removal of the organ, unless a counter-opening is made through the loin. Of course, a great advantage, as before stated, is that the other kidney can be first examined, and its condition ascertained. As to the technique after exposing the kidney in the manner already described, the organ is freed from its adhesions to surrounding tissues, the surgeon being careful to keep outside its true capsule, but inside the layer of condensed perinephric tissue. Special precautions must be adopted in dealing with the posterior aspect of the tumour, particularly on the right side, where it is occasionally adherent to the inferior vena-cava. The mass is now lifted from its bed, and its pedicle, consisting of the ureter and renal vessels, isolated. These latter are secured separately by ligature and divided, a clamp being applied to the distal ends. The ureter is dealt with in the same way, small pieces of sponge being packed round so as to receive any secretion which may escape, the exposed mucous membrane in the portion which is left is carefully touched over with pure carbolic acid. The kidney thus freed is

removed, and the wound in the posterior parietal layer of the peritoneum brought together, if possible, by sutures, provision for drainage having been previously made either through the loin or by the insertion of a gauze drain from the front. The abdominal cavity is carefully cleansed from all blood-clot, and closed in the usual way. Considerable shock is always experienced from this operation, and the death-rate from this cause is somewhat high.

The *Lumbar Method* can only be employed when the kidney is not much enlarged. The organ is exposed by the incision already described, enucleated from its surroundings, and the pedicle dealt with as in the abdominal operation. If the condition of the opposite organ has not previously been ascertained, Kocher recommends that the peritoneum should be incised at the outer margin of the wound, so as to enable the hand to be inserted across the middle line, and thus allow an exploration of the opposite loin.

Should it be desirable to include the ureter in the scope of the operation, the incision may be prolonged into the groin in the direction of the fibres of the external oblique, and the peritoneum and its contents pushed forwards, by this means it can be traced down almost to the bladder.

## CHAPTER XXXIX

### BLADDER AND PROSTATE

#### Methods of Examining the Bladder

WHEN a patient presents himself complaining of increased frequency of micturition and other evidences suggestive of chronic disease of the bladder, a systematic examination of the individual and his urinary passages must always be instituted. The history of the case, the character of the symptoms, and the condition of the urine, are carefully gone into. At the first interview it is advisable to ask the patient to void his urine, after which, providing no tight stricture exists, a medium-sized catheter à boule, or one of rubber, should be gently introduced, and the amount, if any, of the residual urine estimated and tested. Having gained all the information possible from this source, an examination of the bladder should then be made, or perhaps at a subsequent visit. (1) The patient is laid on a couch, and the lower part of the abdomen uncovered. The hypogastrium is then examined by inspection, palpation, and percussion, so as to ascertain whether or not the bladder is distended, or if any abnormal resistance can be felt, either from thickening of the wall or the presence of a tumour. (2) A sound is then passed according to the method described at p. 1203, and the interior of the viscus explored, by this means a calculus may be detected, and even sometimes a tumour, as also a rough and irregular condition of the mucous membrane. (3) The finger is inserted into the rectum, or, in the female, into the vagina, before the sound is withdrawn, so as to enable the condition of the posterior vesical wall to be investigated between the point of the finger and the sound. Enlargement of the prostate or of the vesiculæ seminales can also be detected in this way. (4) As mentioned elsewhere, Bigelow's evacuator is useful, not only to wash out the bladder, but also to detect the presence of very small calculi which the sound may have missed. (5) Of recent years a new means of examining the interior of the bladder has been introduced in the shape of the *cystoscope* (Fig. 429). This consists of a straight tube with a short end bent at an angle, in which an electric lamp is placed the wires leading to it being carried within the tube. A small window covered with glass is situated close to the angle, and a prism is here inserted in such a

manner that, when the surgeon looks through an eyepiece placed at the end of the instrument, he is able to see the portion of the vesical wall illuminated by the electric lamp. To use it the bladder must be previously washed out, and the patient anæsthetized. About six ounces of boric acid lotion should be present in the bladder, so as to prevent the vesical wall from being injured by the instrument, which always becomes hot after the lamp has been used for some time. Different ends are supplied to enable the anterior and posterior walls to be examined. Considerable practice is needed for any useful information to be gained by the aid of this instrument, but in skilled hands much may be learnt as to the condition of the mucous membrane. (6) Finally, in cases where great irritability of the bladder exists in spite of treatment, and its presence cannot be

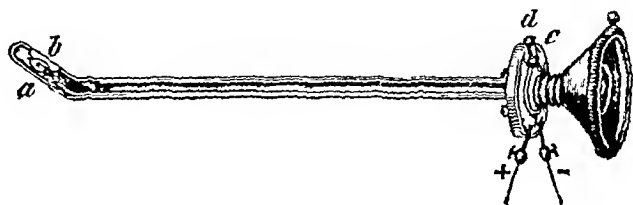


FIG 429 —LEITER'S ELECTRIC CYSTOSCOPE (TILLMANN'S)  
*a*, Electric lamp in beak *b*, glass window for illumination purposes  
*c*, *d*, switch for opening or closing current

explained, an exploratory cystotomy, either supra-pubic or perineal, is justifiable.

A *distended bladder* constitutes a rounded swelling, which projects above the symphysis pubis, and may even reach to the umbilicus in some cases. The swelling may be visible to the naked eye, and is dull on percussion, it is quite immovable, and therein differs from many ovarian and uterine tumours. Bimanual examination *per vaginam* or *per rectum* should at once indicate its nature, and when at all doubtful, a catheter should be introduced.

**Congenital Affections of the Bladder** —1 *Ectopia Vesicæ*, or *Extroversion of the Bladder*, is the term given to denote total absence of the anterior wall of the bladder and of the lower portion of the abdominal parietes, as a result of which the mucous membrane of the posterior vesical wall is exposed and rendered somewhat prominent by the pressure from behind of the abdominal contents (Fig 430, 1). This surface is usually not much more than an inch in diameter in an infant, and is often irregular, and covered with papilliform processes, the orifices of the ureters are easily recognised below, urine being occasionally emitted from them in forcible jets. The condition is necessarily one of the greatest discomfort, not only from the constant dribbling of urine causing excoriation and eczema of the thighs and surrounding parts, but also from the pain and irritation due to friction of the clothes against the exposed mucous membrane. The symphysis pubis is always absent, and the horizontal ramus of the pubic arch terminates on either side in the inguinal region (4). The innominate bones are usually rotated outwards, and the sacrum is convex anteriorly from side to side instead of being concave. In consequence of this pelvic malformation, the patient's gait and powers of progression are considerably impaired. The penis (2) is cleft, and in a condition of complete epispadias, it is drawn upwards and backwards over the trigone, so

that it requires pulling down to expose the ureteral orifices. The testes are often found in the inguinal canal, or, if in the scrotum, are accompanied by congenital herniæ. No umbilicus is present. The condition is due to impaired development of the anterior wall of the allantois and the lower segment of the abdominal parietes. At birth the lower portion of the umbilical cord is expanded over the raw surface, constituting the anterior vesical wall. When the cord separates, the posterior vesical wall is necessarily exposed.

The **Treatment** of this distressing malformation is most unsatisfactory. The majority of the cases are treated by the application of a urinal, but, unfortunately, the instruments hitherto devised are not particularly efficient. Various operative measures have also been practised, with the object of covering the exposed surface, and forming, if possible, a reservoir in which the urine may be retained.

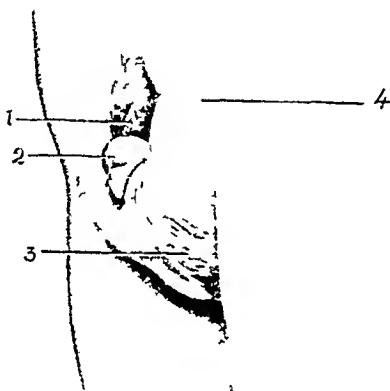


FIG. 430.—ECTOPIA VESICÆ

- 1, Exposed mucous membrane of posterior wall of bladder, 2, glans penis, drawn up to cover lower part of vesical mucosa and orifices of the ureters, 3, scrotum, 4, projection of pubic ramus.

(a) Trendelenburg's operation consists in division of the sacro iliac ligaments from behind, so as to enable the lateral halves of the pelvis to be compressed together. By this means the posterior vesical wall is thrown backwards and its tendency to protrude lessened. The wounds are allowed to granulate, and, if successful, the bladder wall finally lies at the bottom of a sulcus, which can usually be covered over by a plastic operation without much difficulty. The main objections to this method are that it involves a very severe operation, and also leads to a further weakening of the pelvic arch, the integrity of which is already much impaired by the absence of the pubic symphysis. (b) Plastic operations without interfering with the pelvis have been introduced and practised by the late Professor John Wood, Thiersch, and others. For full details, we must refer to larger text-books. Suffice it here to state that a skin flap is turned down from the anterior abdominal wall above the breach of surface, and sutured on either side to the margins of the defect. The cutaneous surface of this flap constitutes the anterior wall of the newly formed bladder, if such it can be called, whilst its raw outer surface is covered in either by flaps derived from either side, or by undercutting the neighbouring skin and sliding it upwards to the middle line, where it is united by sutures, as suggested and successfully carried out by Mr. Boyce Browne. The after-treatment is slow and prolonged and



tedious, and the patients are likely to experience much subsequent inconvenience owing to the growth from the under surface of the abdominal flap of hairs, which become encrusted with phosphates

More recently various methods of implanting the ureters into the rectum have been practised, and it is claimed that the urine is easily retained for some hours, and voided independently of the fæces

2 An **Umbilical Urinary Fistula** is sometimes met with as a result of imperfect closure of the urachus

3 Occasionally in cases of malformation of the rectum the **Primitive Cloacal Condition** may in part persist (see p 1121)

**Traumatic Affections of the Bladder**—**Rupture** may be produced in several ways (1) It may be due to direct violence applied to the lower part of the abdomen, especially when the viscus is distended (2) It may complicate a fracture of the pelvis, either as a direct result of the violence, or from penetration of a spicule of bone from the os pubis (3) The bladder may be opened by a penetrating wound (4) Apart from traumatic lesions, rupture may occur from simple over distension, especially if destructive ulceration of its walls is present, or it may follow ulceration of a saccule if it contains a phosphatic concretion

Rupture of the bladder is divided into two main classes, according to whether or not the peritoneal cavity is opened. The peritoneum covers the upper and back part of the viscus, being reflected anteriorly along the urachus, laterally along the obliterated hypogastric arteries, and posteriorly on to the rectum

**Intra-peritoneal Rupture** involves the posterior or superior portions of the viscus, and is the variety most frequently met with. The symptoms produced are severe shock, associated with hypogastric pain of a burning nature. The patient experiences a constant desire to micturate, but, as a rule, nothing is passed, except perhaps a little blood. Peritonitis soon follows, running a rapidly fatal course, especially if efficient treatment is not adopted. On passing a catheter the bladder is usually found empty, or possibly a little blood-stained urine may be withdrawn, if, however, the instrument happens to be insinuated through the rupture into the peritoneal cavity, a considerable quantity of blood-stained urine can be drawn off, and the point of the catheter may be felt under the anterior abdominal wall. A useful diagnostic sign consists in injecting a measured amount of boric acid lotion into the bladder, and noting how much of it returns, when a rupture exists, some considerable discrepancy will probably be noted between the two quantities, this test cannot, however, always be relied on

The **Treatment** of these cases consists in immediate laparotomy, the fluid within the peritoneal sac is removed by sponges, and the wound in the bladder clearly demonstrated, preferably with the patient in the Trendelenburg position (p 961), which must not, however, be adopted until the urine and inflammatory effusion have been removed. The rent is carefully closed by means of a row of Lembert sutures, which should always extend a little beyond each extremity of the wound. Possibly a drainage-wick or a Keith's

tube may need to be inserted for a few hours, so as to remove any exudation. The abdominal wall is then closed in the usual way, and the patient put back to bed. The urine is either drawn off at regular intervals, or a catheter may be tied in the bladder, the urine being syphoned by an attached rubber tube into a vessel placed beneath the bed.

**Extra-peritoneal Rupture** of the bladder involves its anterior wall or base. The urine finds its way into the pelvic cellular tissue, and, if unhealthy, at once gives rise to a most virulent form of suppurative pelvic cellulitis, which is usually fatal from toxæmia or pyæmia. Abscesses generally point either above the pelvic brim or in the perineum. The treatment consists in free incisions through the perineum, or above the brim of the pelvis. If the urine is healthy and uncontaminated with bacteria, and is not allowed to remain long in contact with the tissues, the prospects of recovery are good.

**Foreign Bodies** introduced into the bladder from without are of various natures, such as portions of catheters or bougies, pins, etc. They give rise to symptoms of chronic cystitis, and usually become encased with phosphatic deposit. They should be removed as early as possible with a lithotrite, but if of large size or thickly covered with phosphates, must be treated by perineal or suprapubic cystotomy. In the female digital dilatation of the urethra is the best means of gaining access to the interior of the viscus.

**Cystitis** may be due to a great variety of causes, but is always in essence of bacterial origin. Many different forms of bacteria may be found, but those most usually present are the ordinary pyogenic cocci, especially the *Staphylococcus aureus*, which, together with the *Diplococcus ureæ liquefaciens*, has the power of decomposing urea and setting free ammonia, whilst the *B. coli* is also commonly found in these cases. This latter organism has no power of rendering the urine alkaline, and hence if present in a pure infection the urine remains acid, though stale and offensive to the smell. The methods of invasion of the bladder are diverse. (1) Bacteria may reach the viscus from above, either owing to a suppurative lesion of the kidney or its pelvis, or being filtered with the urine from the blood. (2) They may travel up the urethra. This is a matter of no difficulty in the short and comparatively large urethra of a woman, and hence cystitis is frequently associated with vulvitis or is seen after labour. In girls a pure bacillary cystitis with acid urine is not uncommon, and is probably secondary to a vulvo-vaginitis which arises from contamination of the vulva from the fæces where cleanliness is neglected. In the male sex, infection by the urethra is unusual unless urethritis has previously existed or some irritation, due to the passage of instruments. Even if they are carefully sterilized, mucus is liable to form and cling about the urethral wall, and along this bacteria can find their way. Naturally the introduction of an unsterilized dirty instrument may suffice to cause cystitis. The gonococcus can necessarily extend backwards to the bladder, and some of the most acute types of cystitis are due to this organism.

(3) Bacteria can invade the bladder from surrounding organs, being transmitted by lymphatic dissemination. Thus an injury of the rectum may easily lead to cystitis.

The mere presence of bacteria in the bladder is, however, not sufficient as a rule to determine an attack of cystitis. Large quantities of pus are frequently discharged from the kidney through the bladder, and that over lengthy periods, and yet no inflammatory reaction follows. Some *local predisposing factor* must be added in order to excite their activity, and amongst the most favourable are the following: (i) Congestion of the mucous membrane, determined by exposure to cold, this is peculiarly liable to occur in gouty individuals, and, indeed, there are people who 'take cold' in their bladders instead of developing a nasal or bronchial catarrh. (ii) Injury, as by the presence of a foreign body, a calculus, or rough handling during an operation, may serve to render bacteria active and virulent. (iii) One of the most important causes is retention of urine, from whatever cause it is due, *e.g.*, enlarged prostate, stricture, etc. The bacteria develop and decompose the urine, rendering it offensive and ammoniacal, and the toxins and irritating bodies thereby produced affect the vesical mucosa. (iv) The presence of irritants in the urine may determine cystitis, as also pyelitis, *e.g.*, after the absorption of cantharides. Other drugs may heighten bacterial activity in some predisposed individuals, *e.g.*, copaiba or cubebs. (v) Loss of nervous control is a most important predisposing factor, and comes prominently into play in spinal injuries. The greatest difficulty is experienced in protecting such patients, and even effective purification of penis, hands, and catheter, and the application of a sterilized dressing to the organ after the catheter has been used, may not suffice to prevent the outbreak of cystitis, which is due to infection from the kidney or rectum. In these patients the disease always runs a virulent course, and is likely to kill the patient by extension up the ureter.

**Pathological Anatomy**—In acute cases the mucous membrane of the bladder becomes congested and thickened, the epithelium is shed, mucus is excreted, and is soon transformed into muco-pus, which may be extremely viscid, and develops in large quantities. Ulceration of the bladder wall may occur, or even sloughing, in the worst cases the whole of the mucous lining may necrose, and be cast off as a slough. Sometimes a membranous form of inflammation occurs, the patient frequently passing flakes of some size, which on examination are found to be chiefly composed of fibrin.

In chronic cases the mucous membrane is thickened and congested, the superficial veins dilated and even varicose, whilst ulceration is not uncommon. The continued repetition of the acts of micturition leads to hypertrophy of the bladder wall, which becomes thickened and fasciculated, this effect is of course most marked when the cystitis is associated with obstruction to the outflow of urine. The mucous membrane may protrude outwards between the muscular fasciculi, giving rise to pouch-like saccules, in which phosphatic concretions are sometimes formed, and the retained

urine undergoes decomposition. Perforative ulceration occasionally follows, originating a fatal peritonitis or pelvic cellulitis from extravasation of urine. The contracted state of the bladder and the overgrowth of its muscular substance lead to compression of the openings of the ureters, hydronephrosis being thus induced. A plug of viscid mucus often finds its way into the ureteral orifice, and by becoming infected with bacteria causes an extension of the septic mischief to the kidney.

The **Symptoms of Acute Cystitis** consist in pain referred to the perineum and hypogastrium, together with tenderness on pressure over the symphysis pubis. This is accompanied by extreme irritability of the bladder, frequent efforts of a painful and spasmodic nature being made to pass water (*strangury*), but little urine is voided at a time, for as soon as any amount has collected it is ejected forcibly. It generally contains blood and pus, soon becoming alkaline, and teeming with bacteria. Some amount of fever is usually noted, as also vomiting, whilst tenesmus may be induced as a result of the proximity of the rectum to the inflamed bladder. The usual termination of the case is in resolution, but sometimes chronic irritability may persist. In rare instances the inflammation is of such a virulent nature as to cause death. The urine in these cases is often exceedingly foul, and the fatal issue is due to exhaustion, peritonitis, suppurative pyonephrosis, or even acute toxæmia. In some patients, however, when the inflammation is concentrated at the neck of the bladder, retention, distension, and atony may ensue.

**Treatment**—The patient should be kept in a warm atmosphere, and preferably in bed, and fomentations applied to the lower part of the abdomen, hot hip baths twice daily, maintained for some time, are very advantageous. The diet should be restricted to fluid, and the patient encouraged to partake freely of barley-water and other bland liquids. Alkalies and henbane may be administered, and morphia and belladonna suppositories are useful to allay the pain and irritability. As a rule, no instrument should be passed during the acute stage, unless retention is present, but if the urine becomes very foul, the bladder may be gently washed out, or even drainage of the bladder through the perineum may be necessary (see Perineal Cystotomy, p. 1185). In the worst cases uratropine (5 to 10 grains), salol (10 to 20 grains), and boric acid (15 to 20 grains), administered by the mouth, may do good.

**Chronic Cystitis** is much more common than the acute variety, and is usually associated with some irritation of the walls of the viscus, as from calculi, tumours, foreign bodies, tuberculous ulceration, or retention and decomposition of urine, especially if associated with obstruction to the outflow, as by a stricture or enlarged prostate. It may also follow acute cystitis.

The **Symptoms** are those of irritability of the bladder, the patient constantly desiring to pass water, and having to rise at night, perhaps several times, for this purpose. The urine becomes turbid, and on standing deposits a variable amount of mucus or muco-pus, mixed

with epithelial cells, crystals of triple phosphate, and a granular sediment of phosphate of lime. It is usually alkaline, perhaps foul-smelling and ammoniacal, containing an abundance of micro-organisms. There is often but little pain, though when a calculus exists, or the neck of the bladder is ulcerated, this may become a prominent symptom. The patient's general health is not at first affected, but if the symptoms persist it soon becomes impaired, partly from the absorption of septic products from the bladder, and partly from the want of rest and sleep arising from nocturnal disturbance, and this may be so marked as to lead to fatal exhaustion. In other cases the inflammation may spread from the bladder along the ureters to the kidneys, and the phenomena of septic pyelonephritis manifest themselves (p 1160).

The **Diagnosis** of chronic cystitis is readily made from the characteristic symptoms of irritation of the bladder and the condition of the urine, but considerable difficulty may be experienced in determining its cause. In investigating a case, not only must the character of its onset be considered, but also the general history of the patient, whilst a thorough examination of the lower urinary passages must be instituted, and the urine examined microscopically. The passage of a catheter or sound will generally detect any obstruction located in the urethra, whilst the bladder is also examined by the different methods described at p 1177.

The **Treatment** of chronic cystitis is naturally directed towards its cause, if such can be discovered, thus, calculi or foreign bodies should be removed, and strictures dilated. In most cases, even where the cause is not apparent, great benefit will be derived from washing out the bladder.

The bladder is best irrigated by passing a soft rubber instrument, to the end of which is attached a portion of drainage tube about 3 feet long, and beyond this a glass funnel, into which the material employed is poured. By raising the funnel the fluid runs into the bladder, whilst on depressing it below the bed or couch the fluid returns on the syphon principle. The patient's sensations must guide the surgeon as to how much fluid can be borne in any particular case. Various solutions are employed for this purpose, but perhaps the most useful are weak Condyl's fluid, sanitas (1 in 10), boric acid (20 grains to 1 ounce), perchloride of mercury (1 in 2,000), or a neutral solution of quinine (2 grains to 1 ounce), and they may be used alternately with advantage. The frequency with which the injections are made must vary with the severity of the symptoms, it is not often necessary to perform the operation more than once or twice a day. Of course, the most stringent precautions must be taken as to sterilization of the patient's penis, of the surgeon's hands, and of the instruments employed.

At the same time that this local treatment is being adopted, the patient's general habits of life must be regulated. The diet should be bland and unstimulating, alcohol is better avoided, but if essential for other reasons, well-diluted gin or whisky may be given. Tea and

coffee should be prohibited, whilst milk should be given freely, together with barley-water and some mild alkaline water, such as that derived from Contrexéville. As to medicines, there are none which can alter the reaction of the urine from alkaline to acid, but perhaps salol, boric acid, or benzoic acid may be of some assistance. Urotropine is useful, acting by setting free formalin in the bladder. Hot infusions of buchu, uva ursi, and triticum repens, act as mild diuretics, and as alteratives to the vesical mucous membrane, full doses, however, such as a pint or a pint and a half in the course of the day, are needed. Where much muco-pus is excreted, copaiba, cubebs, turpentine, or sandal-wood oil may be given, whilst injections of dilute astringents have been advised, but must be used with caution.

In cases which do not improve, and if the patient is becoming exhausted from the constant interference with his rest, etc., the only means of treatment left is that of opening the bladder through a perineal incision. **Perineal Cystotomy** is undertaken not only for the

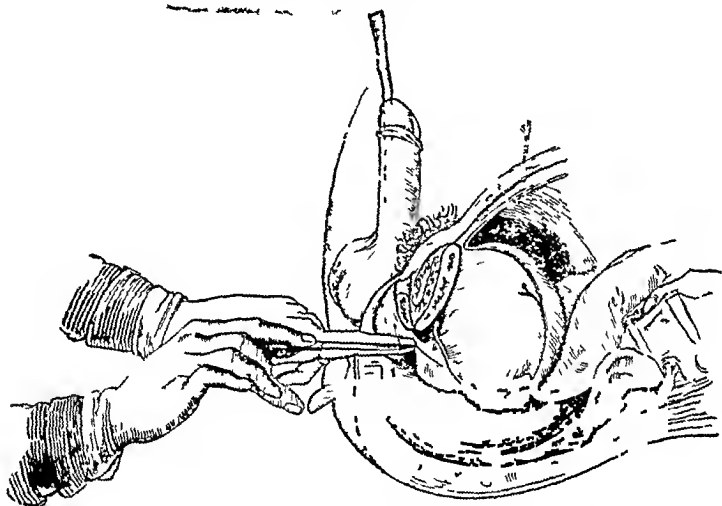


FIG 431 —PERINEAL CYSTOTOMY (FERGUSSON)

draining of a chronically inflamed bladder, but also to explore the mucous lining of the viscus, to remove growths and foreign bodies, as also sometimes to deal with prostatic enlargements and calculi. The bladder is first thoroughly washed out, a few ounces of antiseptic solution being left within it. After anæsthesia has been induced, a staff with a median groove is passed into the bladder, and then the patient is placed in the lithotomy position, and the perineum shaved. An incision is made in the middle line of the perineum, from a point  $2\frac{1}{2}$  inches in front of the anus to about 1 inch from that opening. The knife divides the deeper structures of the perineum, and, guided by the left index finger in the wound (Fig 431), is made to enter the groove in the staff at a point corresponding to the membranous portion of the urethra. It is then carried upwards and backwards along the groove, incising the prostate and entering the bladder.

The knife is carefully withdrawn, the finger gently inserted into the bladder, and the staff removed. After digital exploration of the bladder, a full-sized gum-elastic catheter (No 16 or 18) is passed in through the wound and fixed, a long piece of rubber tubing being attached to allow of the constant escape of the urine, as well as to permit of occasional irrigation. The catheter is removed and changed at the end of forty-eight hours, and in favourable cases may be discontinued altogether at the end of a week, in severer cases a permanent opening may have to be maintained.

**Complications and Dangers of Perineal Cystotomy**—(1) *Hæmorrhage* may arise from three sources—the superficial arteries of the perineum, the deep branches of the pudic (especially that which passes to the bulb), and the veins of the prostatic plexus. The first of these are divided in the superficial incision, and may be readily secured, if necessary, by forceps and ligature. The artery to the bulb is not likely to be wounded if the incision is limited anteriorly according to the directions given above, if, however, this trunk or its branches in the bulb are cut, free arterial hæmorrhage follows, which is usually stopped without difficulty by opening up the wound and searing the bleeding points with forceps. Venous hæmorrhage from the prostate is a more serious matter, and is especially prone to occur in elderly persons with prostatic hypertrophy. It is recognised by venous blood welling up from the depths of the wound, or possibly, if not evident at the time of the operation, by the bladder becoming distended with clot, considerable pain being thereby induced. If noticed during the operation, it is treated by syringing out the wound with iced lotion, and the insertion of an au-tampon or a petticoated tube. The former contrivance consists of a gum elastic catheter, the deep portion of which is surrounded by an indiarubber bag, which can be inflated with air through a small tube fitted with a stop-cock, to which a force pump can be attached. The petticoated tube is used when the litter is not obtainable or fails to act, it is made by tying a petticoat of lint or gauze around the distal end of a vaginal tube, this is then passed into the bladder, and the space between the petticoat and the tube packed with gauze. If the bladder becomes filled with blood-clot, this must be broken up and removed by syringing with hot water through a large-eyed catheter, and the wound subsequently plugged around a catheter. (2) A *Wound of the Rectum* may be caused by carrying the incision too far backwards, or by not maintaining the point of the knife strictly in the groove, it is more liable to happen, however, whilst withdrawing the knife, the point being swept backwards, thus opening the bowel. It is often not recognised until flatus and fæces are passed through the wound at a later date. If of small size and situated low down, it will probably close by cicatrization without special treatment, but when high up and more extensive, a recto-vesical fistula is likely to follow. The treatment usually recommended in such a case is to divide the sphincter, and thus lay the lower end of the rectum and the cystotomy wound into one cavity, the communication being sometimes closed by the contraction of the granulation tissue which fills up the wound. In suitable cases it may be possible to stitch up the opening from the rectum after paring its edges. (3) *Pelvic Gleetulitis* is caused by cutting beyond the limits of the prostate, and thus opening up the recto-vesical fascia, or by bruising and over-distension of the neck of the bladder by dragging through it too large a stone. In either case urinary extravasation and diffuse septic inflammation are likely to follow, resulting in grave constitutional disturbance of a septic nature, and possibly in the death of the patient. The treatment suggested is to support the general health by suitable diet and stimulants, whilst local tension is relieved by extending the wound backwards, even into the rectum. (4) An acute ascending pyelonephritis is occasionally lighted up, in spite of all precautions, and cannot be prevented. For symptoms, etc., see p 1160.

**Tuberculous Disease of the Bladder** may be primary or secondary, the latter being the more usual and extending from the kidney,

prostate, or testicle It is much more common in men than in women, and is most frequently seen in young-adults It commences in the submucous tissue as a deposit of milary tubercle, which caseates and suppurates, breaking down, and giving rise to ulcers with undermined edges, these are rarely of large size at first, are usually multiple, and situated in or near the trigone The **Symptoms** are those of chronic cystitis and hæmaturia, the irritability of the viscus being very marked The diagnosis is made by demonstrating the bacillus of tubercle in the urine, and by the cystoscope The course of the case is unfavourable, the ulcers increasing in size, and death resulting from exhaustion, general infection, phthisis, or extension to the kidneys

**Treatment**—The case is usually treated for some time as one of chronic cystitis before its nature as a tuberculous affection is ascertained In the milder cases it may suffice to attend to the general health and hygiene of the individual, and to wash out the bladder with some antiseptic two or three times a week, leaving a drachm or two of a 10 per cent. solution of iodoform in olive-oil or glycerine within the viscus In more advanced cases cystotomy has been undertaken by the suprapubic method, and the ulcerated surfaces scraped and disinfected by applying the galvano-cautery or pure carbolic acid To effect this the method suggested by Mr Hurry Fenwick, of using a suitable speculum as a caisson through which to work, is especially to be recommended It is doubtful, however, whether such practice is of much ultimate value When the primary lesion in kidney or testis is efficiently treated, a secondary bladder trouble often improves

Very similar **Symptoms** may be induced by the presence of a **Simple Ulcer of the Bladder**, which, according to Fenwick, occurs not unfrequently It is usually single, and situated near the neck or trigone, giving rise to great irritability of the viscus and hæmaturia, although the urine remains clear The diagnosis is best made by the cystoscope Phosphatic deposits sometimes form over the ulcerated surface, and may suggest the existence of a stone Treatment consists in washing out the bladder with lactic acid ( $\frac{1}{2}$  to 3 per cent), or in scraping and cauterizing the base of the sore through a suprapubic incision

**Tumours of the Bladder**—New growths from the vesical wall are not very uncommon, they may be simple or malignant

**Simple Tumours** occur in the form of fibroma and myxoma, but that most often seen is the **Papillomatous or Villous Tumour**, which appears as a soft flocculent mass, usually situated near the trigone, and close to the opening of one of the ureters (Fig 432) The floating tufts or villous processes consist of an extremely delicate connective tissue, covered with a layer or two of epithelium similar to that lining the bladder, and traversed by bloodvessels Occasionally the growths have a narrow base, and are pedunculated, but more frequently are sessile They may be single, or may multiply rapidly, and spread all over the bladder by infection from the primary growth



The **Symptoms** are those of recurrent hæmorrhage, the blood being of a bright red colour, followed later on by irritability of the bladder. At first the hæmorrhage is intermittent, considerable intervals occurring between the attacks, but subsequently it becomes more continuous. The irritability of the bladder is generally induced by chronic cystitis, and when the urine has undergone alkaline changes, there is a copious exudation of ropy mucus, which, mixing with the urine, causes considerable difficulty in micturition, leading in some cases to strangury. On standing, this deposit becomes so tenacious

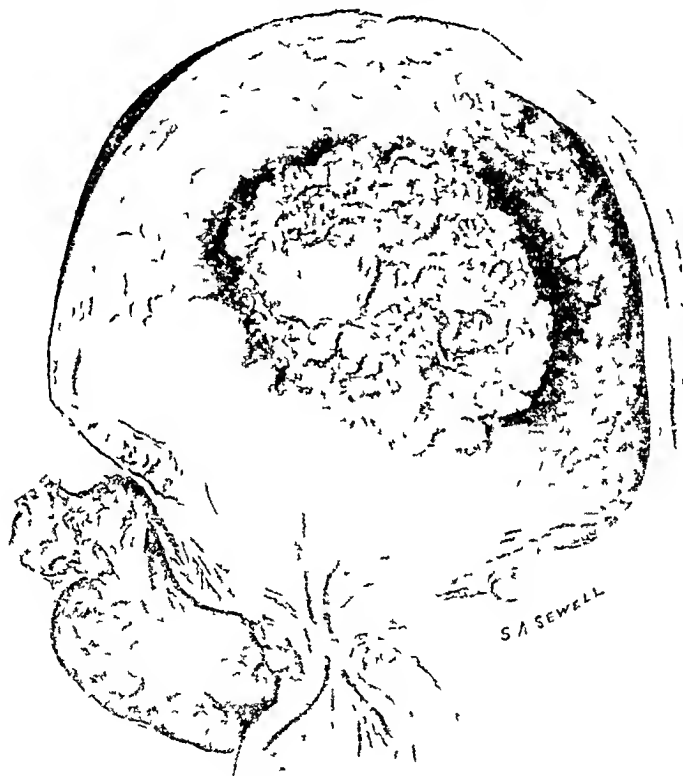


FIG 432 —VILLOUS TUMOUR OF THE BLADDER (FROM KING'S COLLEGE HOSPITAL MUSEUM)

and jelly-like as to be poured with difficulty from one vessel to another. The urine may also contain portions of the tumour which have been set free, and occasionally, if situated near the neck of the bladder, some of the fimbriated ends may be swept into the urethral orifice, and interfere with micturition. In the same way the opening of one or both ureters may be encroached upon, leading to hydro-nephrosis. On examination of the bladder with a sound, nothing definite can be detected, unless the surface of the growth becomes encrusted with phosphates, and no abnormality is noticed on rectal

examination Occasionally a small portion of the growth may be caught in the eye of a catheter

The **Prognosis** of the case is unsatisfactory, since, although the growth is not at first malignant, it often becomes so, and leads to a fatal termination through exhaustion, hæmorrhage, or septic complications

**Sarcoma** of the bladder is an unusual disease, more often seen in children than in adults— In the former it gives rise to multiple polypoid growths, in the latter it is usually single and sessile The tumour grows rapidly and may attain considerable dimensions,

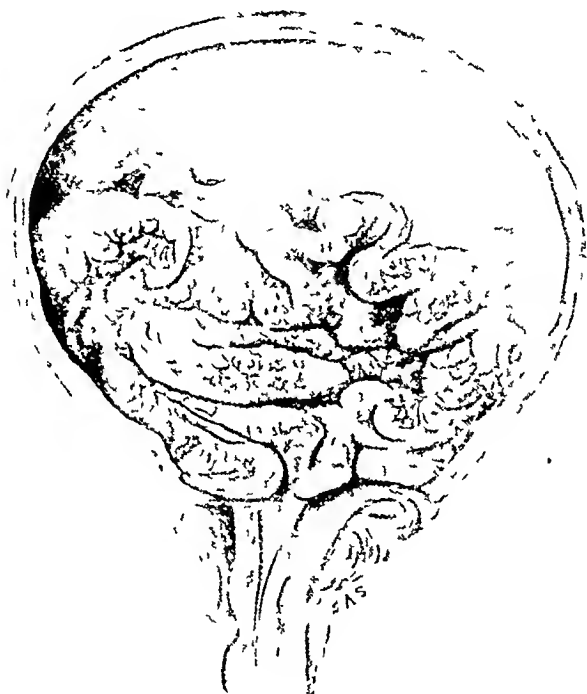


FIG 433 --CANCER OF BLADDER (ROYAL COLLEGE OF SURGEONS MUSEUM )

spreading outside the bladder and even invading the pelvic bones Lymphatic glands are often implicated at an early date

**Cancer** of the bladder may originate in that viscus, or may spread to it from the rectum or neighbouring organs In the former case, a squamous epithelioma is the usual type, in the latter, the nature of the growth is, of course, similar to that of the primary disease, thus, when secondary to rectal cancer, the tumour is of a columnar type Most frequently the affection commences in the posterior wall above the trigone, extending forwards to the neck of the bladder The growth is sometimes superficial, projecting into the vesical cavity as a soft spongy mass, which does not ulcerate early, or invade the muscular walls till late, but more frequently the neoplasm extends into and infiltrates the walls, whilst marked ulceration is also

present (Fig 433), the raw surface often becoming coated in places with a phosphatic deposit. A cancerous growth in the bladder is always more or less likely to become papillated. The disease is much more common in men than in women.

The **Symptoms** vary somewhat in these two forms, although the conspicuous features of each are hæmaturia and irritability of the bladder. In the slowly growing superficial variety, the tumour often attains a considerable size before causing any trouble, beyond possibly some slight irritability of the bladder. A severe attack of hæmaturia, unaccompanied by pain, is usually the first symptom of importance, and may be induced by some injury which causes a crack or fissure in the growth. This painless hæmaturia closely simulates the early symptoms of a simple villous tumour, but is more persistent, and yields less readily to treatment. After one or more of such prolonged attacks, cystitis follows, and the subsequent history resembles that of the harder and more rapidly growing infiltrating tumours. In such the symptoms of vesical irritability precede those of hæmaturia. Dysuria and severe pain referred to the bladder and perineum are complained of, and the urine early becomes alkaline and putrescent, shreds of the growth may also be found in the urine on microscopic examination. If the tumour involves the internal meatus, micturition may be considerably impaired, whilst if the orifices of the ureters are obstructed, hydronephrosis results. On passing a sound, the tumour can be detected as an irregular mass projecting into the bladder, whilst the posterior vesical wall may be felt *per rectum* to be hard and resistant, its ulcerated surface may also be seen with the cystoscope.

The course of the case is similar to that of a somewhat rapidly growing carcinoma, leading to early and marked cachexia, increased by the sleeplessness resulting from the vesical irritation, secondary deposits are found in the viscera and lumbar glands, whilst perforation of the wall may occasionally follow, causing urinary extravasation, septic cellulitis, and death. Another most distressing complication is the establishment of a recto-vesical fistula, through which the urine makes its way into the rectum, thus intensifying the sufferings of the patient.

The **Diagnosis** of a vesical tumour can only be made with certainty by the cystoscope, or by discovering fragments of its substance in the urine, though in the female it is easy to dilate the urethra, and explore the bladder with the finger. Whenever hæmorrhage is associated with marked vesical irritability, and cannot otherwise be explained, a tumour of the bladder may be suspected. The question as to whether or not it is malignant can only be determined by a careful examination of the symptoms. In simple-papilloma and the superficial type of epithelioma, hæmorrhage precedes the irritability, but whilst it is usually impossible to detect the villous growth either by examination with the sound or from the rectum, a fungating malignant growth may sometimes be recognised by the sound. In the infiltrating type of malignant disease, on the other hand, pain

and dysuria always precede the bleeding for a considerable interval, whilst definite evidence of the existence of the growth can usually be made out, both by the sound and on rectal examination. A worn and exhausted appearance must not be looked on as necessarily the outcome of advanced cancerous cachexia, since the loss of rest and sleep due to chronic vesical irritability can of itself lead to a somewhat similar condition.

**Treatment of Tumours of the Bladder**—In the early stages, when the diagnosis of a tumour has not been confirmed, the hæmaturia may be treated with ordinary hæmostatic remedies, such as a mixture containing dilute sulphuric acid and ergot, or turpentine administered in capsules (10 minims three times a day). When once a diagnosis has been established, removal by operation is the only plan which holds out any hope to the patient, and such can only be undertaken with any prospect of success in benign growths, or in the very earliest stages of the superficial form of malignant disease. The bladder is laid open either by perineal or suprapubic cystotomy, and the growth removed by the curette. The suprapubic operation is certainly preferable, in that it gives one the opportunity of definitely seeing the interior of the bladder. The plan already mentioned of employing an expanding speculum as a caisson will be found useful, when all moisture has been sponged away or sucked up, the vesical wall is seen at the bottom of this tube by means of an electric lamp fitted to the surgeon's head. In default of a better instrument, a Ferguson's speculum can be utilized. Papillomata are removed, together with the mucous membrane from which they grow, by cutting round them with the knife or scissors. Bleeding is stopped by pressure of sponges or of strips of gauze soaked in adrenalin. The fingers of an assistant in the rectum will suffice to press up the posterior wall and to give support. If possible, the incision in the mucous membrane should be closed by stitches. Carcinomatous growths are seldom suitable for removal, but possibly some benefit may be derived by scraping away the projecting part with a curette.

When removal is impracticable, it only remains to ease the patient's sufferings by means of morphia, the bladder also being occasionally washed out, but if the irritability is very great, a permanent suprapubic or perineal opening may be established.

### Functional Derangements of the Bladder

**Incontinence of Urine**—A patient is said to be suffering from incontinence when the urine escapes involuntarily, dribbling away either constantly or intermittently from the urethra.

1 **Active Incontinence** is often present in young children, mostly boys. It results from some condition of increased excitability of the urinary apparatus, and is looked on by some as of a choreic nature, in other instances, it is probably due to weakness of the sphincter vesicæ, which is unable to resist the pressure induced by even a small amount of urine. The chief sources of irritation are phimosis,

ascarides in the rectum, a rectal polypus, or urine of high specific gravity, containing uric acid crystals in suspension. The affection is most obvious at night, and, indeed, may only occur during sleep, it has been known to persist till adult life is reached. Somewhat similar in nature to this is the irritability of the bladder induced by calculus, inflammation, or ulceration, where frequent calls to micturition are experienced, to this, however, the term 'irritability of the bladder' is applied, 'incontinence' being only used where no active disease of the viscus is present.

✓ **Treatment** of the nocturnal incontinence consists in the removal of all sources of irritation, such as a tight foreskin, whilst the child is waked from sleep at regular intervals in order to pass water, so as to break him of the bad habit. Tonics, *e g*, iron, arsenic, and quinine, may be administered, and tincture of belladonna should also be given in full doses. Instruments have been used for compressing the urethra at night, and are stated in some cases to have effected a cure.

2 **Passive Incontinence** is said to be present when the neck of the bladder is relaxed, so that as soon as any urine is secreted, it flows out of the urethra, the bladder in this way never becoming distended. It arises mainly from two causes. (a) *Paralysis* of the sphincter vesicæ, as a result of some injury or disease of the spinal cord, which may impair its function either temporarily or permanently. Thus, in severe shock, the bladder is unconsciously evacuated from relaxation of the sphincter, but if the lumbar cord is not compressed or destroyed, the function is soon regained. Any lesion involving the centre for the sphincter necessarily destroys its future utility, and results in permanent incontinence. It is quite possible for the detrusor centre to be damaged without injury to the sphincter, and in such a case distension of the bladder with subsequent overflow supervenes. Paralytic incontinence occasionally follows overdistension of the female urethra for the removal of a calculus. Nothing can be done for either of these conditions, if permanent, beyond the application of a suitable urinal. (b) *Mechanical Incontinence* sometimes results from the impaction of a calculus in the internal meatus, or from its dilatation by a pedunculated growth from the prostate.

3 **False Incontinence, or Distension with Overflow**, is due to any condition in which the outflow of urine is impeded to such an extent as to lead to a certain quantity being left in the bladder after every act of micturition, although the patient imagines that the organ has been completely emptied. This so called *residual urine* gradually increases in amount until the bladder becomes filled, and then some of it dribbles away involuntarily so as to wet the patient's clothes. In old-standing cases the bladder can be detected as a tense, rounded swelling in the hypogastrium. This condition is usually met with in patients with neglected stricture or enlargement of the prostate, and in the latter case the bladder may be so distended as to contain several pints of urine. Very much the same state of things obtains in paralysis due to spinal mischief. Treatment must be directed

to keeping the bladder emptied by the regular use of the catheter, but it often remains in an atonic state for some time

**Atony of the Bladder** is the term applied to a condition in which the patient is unable to expel its contents, not in consequence of any true paralysis of the muscular walls, but simply from loss of tone. The most usual causes are (1) Chronic overdistension, the result of obstruction to the outflow, owing to enlarged prostate or stricture, as just described (2) a single prolonged voluntary or involuntary overdistension, for instance, owing to the oversight of a house-surgeon, a patient suffering from retention after an operation for varicocele was left unrelieved for more than twenty-four hours, whereby atony was induced (3) It occasionally follows cystitis, especially that of gonorrhœal origin (4) In old age atony is sometimes due to simple loss of nerve tone, a condition very similar to that which occurs after or in the course of infective fevers, such as typhus, and is even met with after influenza

In the slighter cases all that is noticed is some hesitation or difficulty in commencing the act of micturition, whilst the flow of urine is weak, and cannot be efficiently completed, a few drops dribbling away afterwards. In worse cases a considerable amount of residual urine may be left in the bladder, and this may lead to chronic distension with overflow, and by its decomposition to chronic cystitis. In other cases actual retention may be induced. The **Treatment** should be directed to removing any source of obstruction which exists, whilst regular catheterism two or three times a day will prevent any distension of the bladder, and the administration of strychnine, phosphoric acid, and other tonics, will improve the expulsive power of the viscus. The passage of a constant current of electricity may also be employed two or three times a week, to stimulate the muscular fibres, one electrode is inserted into the bladder, and the other placed over the hypogastrium

**Retention of Urine** — When a person is unable to expel the contents of the bladder, so that it becomes distended, retention is said to be present. It results from a variety of conditions, classified as follows (1) *Penile and urethral* causes, *e.g.*, phimosis, or congenital occlusion of the urethra, a ligature or ring placed around the penis, impacted calculus, the so-called congestive or spasmodic stricture, organic stricture, urethral or perineal abscess, ruptured urethra, etc. (2) *Prostatic* causes, *e.g.*, inflammation, abscess, tumour, hypertrophy, calculus. (3) *Vesical* causes, *e.g.*, atony, paralysis, calculus, tumours, etc. (4) *Reflex* irritation, such as occurs after operations on the rectum and anus, or involving the spermatic cord. (5) *Hysteria*. (6) *Pressure* from neighbouring organs or external tumours, *e.g.*, uterine fibroids or retroversion of the gravid uterus. In investigating any particular case the age and condition of the patient must be taken into consideration, and also the character of any preceding urinary symptoms, whilst a careful examination should be made. Speaking generally, one may state that the most common cause of retention in infants is phimosis, in children, impacted calculus, or a

ligature around the penis, in young men, gonorrhœa or one of its complications, in young women, hysteria, or foreign bodies in the bladder, in adult men, stricture, in adult women, some uterine condition, and in old men, hypertrophy of the prostate

If left unrelieved, the urine accumulates and the bladder becomes distended, giving rise to much pain and discomfort. One of two conditions is certain to follow (a) In cases of retention from stricture the dilated urethra behind the seat of obstruction gives way, resulting in extravasation of urine. If, however, the bladder wall is weakened by the presence of sacculation, rupture of a sacculum may follow, causing pelvic extravasation. (b) When the retention arises from atony or paralysis, or from some obstruction which can be to some extent overcome, distension with overflow is produced.

Inasmuch as retention is merely a symptom, the treatment necessarily varies with the cause.

### Abnormal Conditions of the Urine

1 **Urinary Deposits**—*Uric* or *lithic acid* is eliminated in the form of 'cayenne-pepper' granules, usually known as gravel. On microscopic examination, the granules are found to consist of flat rhomboidal, lozenge-shaped plates, or masses of acicular crystals (Fig 434). They are of a dusky brownish-red colour, due to the absorption of urobilin, the normal pigment of the urine. The secretion in these cases is always acid, and usually of high specific gravity. The deposit is not soluble in boiling water, but readily so in alkaline fluids, and on reacidulating such a solution, the uric acid is precipitated in the shape of white needle-shaped crystals.

*Urates* or *lithates* of potassium, sodium, or ammonium are of frequent occurrence in the urine, appearing as a deposit of amorphous granules of variable colour, according to the amount of urinary pigment present, and this is often known as a 'lateritious,' or brick dust sediment. The ammonium salt is sometimes found in the shape of spiculated globular bodies (Fig 435). Urates always occur in acid urine of high specific gravity, and are freely soluble in boiling water, on the addition of dilute hydrochloric acid the uric acid is precipitated. The *murexide* test may be applied for either uric acid or its salts, it consists in mixing the substance to be tested with a little nitric acid, and evaporating to dryness, when an orange-red discoloration is produced, which on the addition of liquor ammoniæ changes to a deep purple-red.

A deposit of uric acid or urates is either a temporary condition dependent on some trivial derangement of the system, or a phenomenon constantly recurring and due to too great an indulgence in nitrogenous food, too little fresh air and exercise, or imperfect digestion, the result of some hepatic disturbance. It is also noted in conditions where great tissue change is occurring, as after violent exercise or in fevers. Under these circumstances the materials which should be changed into urea are transformed into uric acid or its salts.

When such a tendency is continually present, the patient is often said to be suffering from **Lithiasis** or **Lithæmia**. Should the individual be incapable of eliminating the material thus formed, an attack of gout is likely to supervene, whilst it must always be borne in mind that the formation of a uric acid calculus is merely a manifestation of the same diathesis, which needs careful treatment after the removal of the stone, if a recurrence of this painful affection is to be prevented.

The **Treatment** of lithæmia or lithiasis consists mainly in attention to the personal hygiene. The patient's diet is regulated, all sweets, pastry, and alcoholic stimulants (with the exception, perhaps, of a little whisky well diluted with lithia or potash water) being avoided. Regular habits are enforced, and plenty of outdoor exercise recommended. The hepatic secretion is stimulated, and the bowels regu-

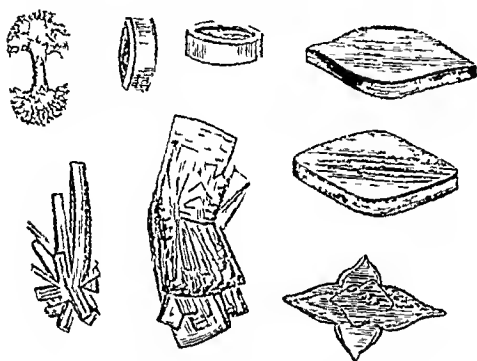


FIG 434 —URIC ACID CRYSTALS



FIG 435 —URATE OF AMMONIUM  
IN AMORPHOUS GRANULES AND  
HEDGEHOG-SHAPED BODIES

lated by the administration of saline purgatives, especially natural mineral waters, *eg*, Friedrichshall, Carlsbad, or Hunyadi Janos, whilst an occasional dose of blue pill or podophyllin is advisable. Lithia salts and piperazine have also been employed with advantage.

*Oxalate of lime* usually occurs in the urine of dyspeptic and hypochondriacal patients, who are pale, nervous, and irritable. It is supposed to arise from the incomplete oxidation of carbohydrate foods. The urine is of low specific gravity, pale and abundant in quantity, and slightly acid in reaction; an excess of mucus is usually present, causing the crystals to adhere to any irregularities in a test-glass. On microscopic examination they are found to be regular octahedra, or in the shape of dumb-bells (Fig 436). The *treatment* of oxaluria consists in regulation of the diet, which must be light and nourishing, all heavy food being avoided, as also rhubarb, which contains large quantities of oxalates, and the patient is directed to drink only boiled or distilled water. Tonics, such as mineral acids, iron, and quinine, may be ordered, but the best treatment consists in change of air and removal, if possible, from causes of anxiety and worry.

*Phosphatic* deposits in the urine occur in three forms. (1) The triple phosphate, or ammonio-magnesian, is found in alkaline or decom-



posing urine, and is always vesical in origin. It exists in the form of hexagonal prisms, three of the sides, however, being very narrow, the ends also are bevelled off, so that the appearance of a 'knife-rest' is produced (Fig 437) (ii) The amorphous-phosphate of lime is exceedingly common, forming the main mass of any phosphatic sediment. It is always present in chronic cystitis, and is not unfrequently met with a few hours after a meal, constituting what is known as the 'alkaline tide'. This condition is often observed about twelve o'clock in the morning, especially if an alkaline saline purgative has been taken before breakfast. The phosphatic material is voided at the end of the act of micturition, and may give rise to considerable anxiety on the part of the patient, who mistakes it for seminal fluid (iii) The most usual condition in which phosphates are met with in urine is a mixture of the two varieties described above. Whichever form is present, the deposit becomes more evident on boiling, disappearing, however, on the addition of a few drops of acid. The treatment of

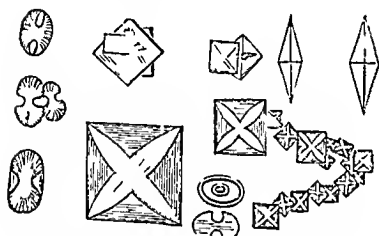


FIG 436 — OXALATE OF LIME IN OCTAHEDRAL CRYSTALS AND DUMB-BELL SHAPED MASSES

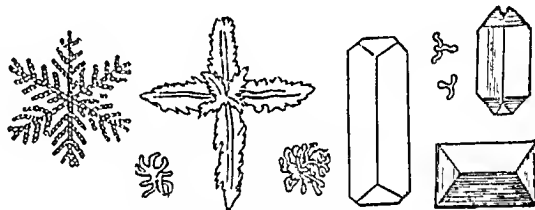


FIG 437 — CRYSTALS OF TRIPLE PHOSPHATE IN URINE

phosphaturia is always directed to the vesical condition, except in those unusual cases where it is due to some constitutional error.

2 **Hæmaturia**, or the admixture of blood with the urine, is best described according to the source from which the blood is derived.

(a) *Renal hæmaturia* results from acute inflammation, congestion, calculus, tumours, or injuries of the kidney. The urine is sometimes deeply coloured with the blood, and may be as dark as porter. Blood casts of the renal tubules are often observed, and even long sinuous clots, corresponding to the shape of the ureter.

(b) *Vesical hæmaturia* is due to injury, calculus, tumours, ulceration, simple congestion of the bladder with varicosity of the vesical veins, or the presence of the *Bilharzia-hæmatobia*. The blood is intimately mixed with the urine, but is more abundant at the end of micturition, and clots are often present.

The *Bilharzia* is a parasite which inhabits some of the rivers and pools of South Africa. It is taken into the system by the mouth, and may develop either in the urinary track, or sometimes in the lower bowel (p 1124). The adult worms are found in the body inhabiting the radicals of the portal and vesical veins, and discharge their ova through the mucous membrane of the bowel or bladder, giving rise to hæmorrhage. By an extension to the kidney, pyonephrosis may

be induced No specific treatment has at present been discovered, but in most cases the disease after a time disappears spontaneously

(c) *Prostatic* hæmaturia may be caused by congestion, calculus, ulceration, or malignant disease, the blood passes back into the bladder, and hence the phenomena simulate the vesical condition Examination of the prostate from the rectum may, however, give a clue to the source of the mischief

(d) *Urethral* hæmaturia arises from acute gonorrhœa, laceration, or instrumentation The blood often flows from the urethra independently of micturition, whilst the first few drops of the stream are also coloured

(e) Hæmaturia is occasionally of *constitutional* origin, arising from purpura, scurvy, or hæmophilia, other manifestations of these diseases will be observed, and render the diagnosis evident

Microscopical examination of the urine should always be made to ascertain whether or not blood corpuscles are present, since the condition may be simulated by that known as 'paroxysmal hæmoglobin-uria,' in which corpuscles are absent The latter condition is supposed to be due to vaso motor spasm of the renal arterioles, and is not uncommonly associated with Raynaud's disease

The only certain test for the presence of blood is by spectrum analysis, but that most usually relied on consists in mixing together equal parts of tincture of guaiacum and ozonic ether The suspected urine is subsequently added, and sinks to the bottom of the test glass, a copious precipitate forms at the line of junction of the two fluids, which on standing becomes a bright blue colour if blood is present

The investigation of a case of hæmaturia in order to ascertain its origin should be conducted in the following way (a) The history of the patient and of his urinary trouble should be taken (b) The character of the urine should be investigated, noting its colour, and whether or not the blood is intimately mixed with it (c) The relation of the passage of the blood to the act of micturition should be noted by making the patient pass the first and last portions of the urine into separate vessels from that in which he passes the bulk, if the urine in all three vessels is equally discoloured, the hæmorrhage usually comes from the kidneys, if most of the blood is in the first vessel, it comes from the urethra or prostate, whilst if the bulk of it is contained in the last vessel, it is probably derived from the bladder (d) Microscopical examination of the urine may lead to the discovery of shreds of tumour, epithelial cells, or blood casts, which could be alone derived from some special part of the urinary track By these means the source of the hæmorrhage, whether from kidney, bladder, prostate, or urethra, may be detected, and an opinion formed as to the nature of the disease

3 **Pyuria** is the term applied to the admixture of pus or muco-pus with the urine It always results from inflammatory affections of the mucous membrane lining the urinary passages, and may be renal, vesical, prostatic, or urethral in origin the methods of investigation, in order to ascertain its exact source, are the same as for hæmaturia

Pus in urine is mainly recognised by the microscope, whilst on the addition of liquor potassæ it becomes ropy

4 **Chyluria** arises from distension or rupture of the lymphatic vessels in the vesical mucous membrane, and is usually due to the presence of the *Filaria sanguinis hominis* (p 361) The urine is milky in colour, and on microscopical examination this is found to be due to the presence of an emulsion of fat

5 **Albuminuria**, or the escape of some of the albuminous contents of the blood with the urine, is a condition of such frequent occurrence, and so important in its results, that the precaution should always be adopted of testing the urine of every patient before undertaking any operative proceedings, and this is the more essential because it is well known that this condition often exists quite unexpectedly and entirely apart from symptoms

**Tests**—Many different methods have been adopted for detecting the presence of albuminuria The following are, however, the chief  
(1) On simply boiling the urine a milky white deposit forms, similar to that which is caused by an excess of phosphates, the latter, however, disappears entirely on the addition of a single drop of dilute acetic acid, whilst the former persists (2) Nitric acid gives a white cloud or light-brown flocculent precipitate The urine should first be boiled, and the acid added, but not in excess, as the deposit may be re-dissolved A more delicate test consists in pouring the cold urine into a test-tube, and carefully adding the acid, so as to form a stratum below the urine, at the line of junction of the two, a white film is formed, if albumen is present (3) With picric acid a yellowish-white precipitate is thrown down, increased by boiling If the urine is neutral or alkaline, it must first be rendered slightly acid by the addition of a few drops of acetic acid

When once the existence of albumen in the urine has been ascertained, its source and its significance must be investigated A careful microscopical examination of the sediment is made, so as to determine whether casts or pus cells are present The condition of the peripheral bloodvessels in the limbs and the character of the pulse should be noted, as also the previous history of the patient

Albuminuria arises from a variety of sources, and its significance necessarily turns on the origin of the affection (1) When it occurs in the course of some disease involving purpuration, such as septic affections of bones or joints, it is due to lardaceous change in the kidneys If the urine is of low specific gravity and light in colour, and with but few casts, only an early stage of the condition is present, and conservative measures directed to the treatment of the primary lesion will probably suffice, if, however, the urine is scanty and of high specific gravity with much albumen and many casts, the affection has probably progressed some way, and radical treatment, such as amputation, should be undertaken to save the patient's life The surgeon must be careful to prevent any undue absorption of carbolic acid in the operation, as thereby acute nephritis may be lighted up, and even a fatal issue determined

(2) Albuminuria may be intermittent, and is then due to some temporary functional disturbance, this can only be ascertained by testing the urine from time to time. In such cases operation is not contra-indicated, the albumen usually disappearing with rest and careful diet. (3) When caused by chronic Bright's disease, the concurrent phenomena of that affection will also be present in the shape of thickened arteries and high pulse tension, whilst possibly a certain amount of anasarca may be noted, or the history of such at an earlier date. If there is but little albumen, and a fair amount of urea is being passed, it is possible by rest and suitable diet so to diminish it as to warrant the performance of slight operations, but where the condition is at all advanced, all *opérations de complaisance* are absolutely contra-indicated, and only the chief surgical emergencies should be knowingly dealt with, viz, hæmorrhage, asphyxia, intestinal obstruction or strangulation, and retention of urine. In cases of severe injuries, amputation is generally indicated under circumstances where in a healthy individual conservative measures would be adopted. Operation for malignant disease may be undertaken at the express wish of the patient, if the increased risks associated with it have been explained to him. The importance of not operating on these patients depends on the facts that they tolerate an anæsthetic badly, that the tissues are in a condition of lowered vitality, and hence the process of repair is hindered, septic inflammations and erysipelas are very prone to develop, whilst secondary hæmorrhage is likely to follow, owing to the high pulse tension. Again, boils and carbuncles are very common in these patients, and where such conditions are met with, and especially if they recur, the urine should always be examined. (4) Albuminuria may arise by extension of inflammation to the kidneys from surgical affections of the lower urinary organs, and a fatal result from shock or suppression of urine may follow an operation under these conditions. (5) It is occasionally the result of cardiac disease, owing to valvular incompetence and regurgitation into the systemic veins, and it is then advisable to delay all operative measures until digitalis has been administered in sufficient doses to alleviate the urgent symptoms.

6 **Diabetes**—The presence of sugar in the urine is also a matter of the greatest importance from a surgical standpoint, and its existence or not should always be carefully ascertained. The chief tests employed are as follows. (1) Equal parts of liquor potassæ and solution of copper sulphate are boiled together, and then a few drops of the suspected urine added, if sugar is present, a yellowish-red precipitate forms by the reduction of the cupric salt to cuprous oxide. (2) The same result follows the use of Fehling's solution. It is better to keep the copper solution separate from the potash, equal parts of them are boiled together, and a few drops of the urine added, if sugar is present, a red deposit occurs. (3) Picric acid and liquor potassæ are mixed and boiled, and the urine added, the presence of sugar is indicated by the solution turning to a dark, blackish-red colour. The admixture of 2 grains of sugar to the

ounce is sufficient to determine this discoloration to such an extent as to render the fluid quite opaque

The effect of diabetes is very similar to that of albuminuria, in that it leads to diminished vitality of the tissues, and consequently predisposes to the occurrence of sepsis, and of such infective inflammations as boils and carbuncles. Peripheral neuritis and sclerosis of the smaller vessels are also induced by this disease in the later stages, and hence gangrene of the extremities is likely to occur, especially in chronic cases and in elderly people. The essential cause of trouble, however, is sepsis, and hence if the most rigid aseptic precautions are taken there is no reason why operative proceedings should not be undertaken in conditions of danger and urgency. Thus several cases have been reported lately in which such serious proceedings as total removal of the breast and axillary

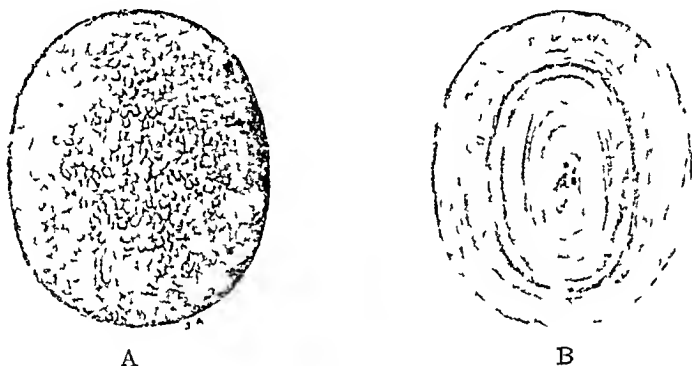


FIG 438 — URIC ACID CALCULUS

A, External aspect, B, on section

contents for scirrhus, or appendectomy, have been safely undertaken in confirmed diabetics

### Stone in the Bladder

**Varieties** —A vesical calculus may be formed of almost any of the urinary deposits commonly met with, and each has its own special characteristics

(a) The *uric acid* calculus (Fig 438) is usually an oval, flattened body of considerable density, with a smooth or slightly nodular surface, and of a nut-brown colour. On section it is distinctly laminated, and it may be surrounded by a crust of phosphatic material

(b) The *urate of ammonium* calculus is of very similar structure, but of a lighter colour, and the lamination is less distinct

(c) The *oxalate of lime* or mulberry calculus (Fig 439) is a rough, irregular body, sometimes evenly nodular, but not unfrequently tuberculated, or even spiculated. It is extremely hard and dense, laminated, and of a dark red-brown colour, or sometimes black, owing

to admixture with blood. It is rarely of great size, on account of the irritation caused by its presence, and its slowness of growth.

(d) A pure *phosphatic* calculus is very uncommon, but any stone or foreign body is certain to become coated with a phosphatic deposit when chronic cystitis has resulted in alkaline decomposition of the urine. Occasionally concretions of a similar nature form spontaneously in saccules of the bladder, such bodies are white and chalky in appearance, friable in consistency, with no evidence, or but little, of lamination, and on removal are exceedingly offensive. These concretions consist of a mixture of the triple phosphate and phosphate of lime. Less commonly an excess of the triple phosphate is present, if in the proportion of two parts of the latter to one of phosphate of lime, a laminated and somewhat denser calculus is produced, which is sometimes termed a *fusible calculus*, owing to the fact that it fuses



FIG 439—OVALATE OF LIME CALCULUS  
A, External aspect B on section

to a bead under the blowpipe flame. Occasionally a phosphate of lime calculus occurs in the upper urinary passages, *e g*, the pelvis of the kidney, and has a crystalline appearance on drying.

(e) *Cystine* forms the basis of a rare calculus which is of a yellowish-green colour and wavy appearance.

(f) *Xanthine*, or xanthic oxide, occurs very exceptionally as a calculus of a reddish colour.

An *encysted* calculus is one which develops in a pocket or pouch connected with the bladder wall. It may consist of any of the above substances, and is due to a small stone finding its way into a saccule and being arrested there. It grows by gradual accretion of new calculous material, and after a time projects into the vesical cavity. A typical illustration is shown in Fig 440, where the large intra vesical portion is separated from the encysted part by a narrow neck. Occasionally this condition is due to the decomposition of stagnant urine in a pouch and the calculus is then phosphatic in composition, it is not unlikely to lead to ulceration of the sac wall and extravasation of urine.

**Structure of a Calculus** — A calculus usually consists of the following parts 1 The *nucleus*, which may be formed by a portion of blood clot, inspissated mucus, a renal calculus, or some foreign substance introduced from without 2 The *body*, which consists of superposed layers of uric acid or oxalate of lime, or of whatever substance the

stone is composed, not unfrequently the composition of adjacent laminae differs, leading to what is known as an *alternating calculus*. Each lamina consists of myriads of minute crystals, held together by vesical mucus, with which a certain amount of phosphatic material is often mixed, whilst layers of pure phosphatic deposit may be interposed 3 The *crust* consists of a variable amount of soft, friable phosphatic material, the quantity of which is the measure of the degree of chronic cystitis originated by the calculus, in some cases it is entirely absent

The **Number** of calculi present in a bladder varies greatly. Sometimes there is only one, occasionally a considerable number, counted perhaps by hundreds, may exist, in such circumstances they are never of great size. Multiple calculi are not unfrequently faceted as a result of mutual friction



FIG 440 — ENCYSTED  
VESICAL CALCULUS RE-  
MOVED BY SUPRAPUBIC  
LITHOTOMY

The **Causes** of vesical calculus must be looked for in some of those constitutional conditions already described as predisposing to lithiasis or oxaluria. They are very common in children during the first decade of life, especially amongst the lower classes, the children of the rich rarely suffering from stone. It diminishes in frequency from childhood to the age of twenty-five, and then gradually increases until it is relatively common in elderly men. The condition is comparatively rare in women, owing to the fact that the shortness and large size of the urethra allow small calculi to be much more readily passed. Possibly the character of the drinking-water, or the amount imbibed, is a matter of importance, as indicated by the fact that the occurrence of calculus is very unequally distributed in different parts of the country, thus, it is most frequently met with in the Eastern Counties. It is also very common in India and Arabia, a fact which may possibly be explained by the large amount of fluid withdrawn from the body by perspiration

**Symptoms** — The effects produced by vesical calculi vary in different individuals, according to the shape of the stone, and the tolerance of the mucous membrane. In children and young adults, where the parts are very sensitive, even a smooth calculus gives rise to severe symptoms, whilst old men often tolerate a large stone without much inconvenience, *ceteris paribus*, an ovalate of lime.

calculus is always more irritating than one composed of uric acid. The classical symptoms of a vesical calculus may be preceded by a history of the patient having passed 'gravel' for a long time, or by an attack of renal colic, on the cessation of which the calculous symptoms commenced. Sometimes the vesical symptoms do not appear for some time after the passage of a stone into the bladder, presumably in consequence of its small size. They consist of pain in the perineum and neck of the bladder, which radiates to the back and down the thighs, but is especially noticed at the end of the penis immediately after micturition. The stone is then pressed down against the sensitive neck of the bladder by the contraction of its muscular walls. Increased frequency of micturition is also present, and perhaps hæmaturia of a vesical type, though this is not a prominent feature. All these phenomena are increased in severity by jolting, jumping, or any form of exercise, and hence are more marked during the day than at night. Occasionally the patient complains that the flow of urine suddenly ceases before the bladder has been completely emptied, and that some change in the position of the body is needed in order to allow him to complete the act. In addition to these characteristic symptoms, he may suffer from various phenomena secondary to the irritability of the bladder, and dependent on the straining induced by the calculus. Thus, tenesmus, followed by piles or prolapsus ani, may be produced by sympathetic irritability of the rectum, especially in children, whilst a hernia may also be caused, and not unfrequently priapism.

The symptoms are somewhat modified in *children*, leading to irritability of the bladder, as evidenced by wetting of their clothes and of their beds at night, and pulling at the prepuce and penis. These manifestations are very similar to those caused by a tight foreskin; with which condition, indeed, a stone is often associated, hence, it is important always to sound the bladder of a child after circumcision for phimosis.

The actual **Diagnosis** of vesical calculus can only be made by *sounding*. In order to accomplish this, the patient is laid on a couch with the head low, and the buttocks raised on a pillow placed beneath them. The bladder should always contain a few ounces of fluid, so as to obliterate any folds produced by laxity of the mucous membrane, as well as to facilitate the introduction of the instrument, the usual antiseptic precautions as to surgeon's hands, patient's penis, instrument and lubricating material, are, of course, rigidly enforced. A sterilized sound of suitable size, warmed and lubricated by some antiseptic oil or ointment, is then gently passed along the urethra, and the handle depressed between the separated legs so as to enable the point to enter the bladder. The handle, which should be cylindrical in shape and fluted, with the maker's name or some mark to indicate the direction of the beak, is then lightly grasped between the index finger and thumb, and rotated from side to side, whilst at the same time the whole instrument is drawn forwards or backwards in the urethra. Each side of the



bladder is thus carefully investigated, and, finally, if no stone is detected, the beak is turned directly downwards, so as to examine the pouch which often forms behind a slightly enlarged prostate. The presence of a stone is recognised by a metallic click, which can be felt and even heard, when the end of the instrument taps it. The character of the click is some guide to the size and density of the stone. The presence of two or more calculi is indicated by the surgeon being able to touch them on rotating the instrument alternately to each side of the middle line, or by seizing one stone with a lithotrite, and using it as a sound for the other. In doubtful cases, a still more delicate test than the sound is obtained by passing a medium sized tube of a Bigelow's evacuator, and washing out the bladder. The calculi may by this means be washed out even from sacculi, and be felt to rattle against the end of the instrument when the pressure upon the indiarubber bulb is relaxed. When the calculi are multiple and of small size, they may be even removed in this way by an examination which was only intended to be diagnostic in character. The surgeon must not forget that a hypertrophied bladder with projecting fasciculi may somewhat resemble a calculus, especially when coated with phosphatic material. In some rare instances a calculus may be so completely hidden in one of the sacculi as to render its detection impossible by these means. An encysted calculus which projects into the bladder is recognised by being always found at the same place.

**Course of the Case** — A patient suffering from vesical calculus is certain, sooner or later, to develop symptoms of chronic cystitis, and septic changes in the urine are equally sure to follow—possibly as a natural sequence, but often as the result of the introduction of septic instruments. The bladder is hypertrophied, and if the stone is not removed, the mucous membrane becomes ulcerated, and the inflammation extends to the kidneys, the patient's life is thus destroyed, partly by exhaustion, and partly by septic or uræmic poisoning.

The **Treatment** of vesical calculus is a matter which has exercised the judgment and manipulative dexterity of surgeons for many generations. A large number of operations have been made use of, but at the present day only three are employed, viz, lithotripsy, supra pubic cystotomy, and very uncommonly perineal cystotomy.

**Lithotripsy** was formerly conducted at several sittings, the stone being crushed, and the patient allowed to pass the debris subsequently, this process was repeated at intervals of a few days, until the bladder was clear. Such a proceeding took a considerable time, and was exceedingly painful, irksome, and dangerous to the patient. The introduction of Bigelow's evacuator completely revolutionized this operation, and enables it to be completed at one sitting, constituting the proceeding sometimes termed **Litholapaxy**.

**Operation** — The patient is carefully prepared by keeping him under observation for a few days, regulating the bowels, and, if possible, reducing any inflammation of the bladder by suitable diet and drugs, and by washing it out. On the preceding night a dose of

castor oil is administered, and an efficient enema a few hours before the operation. The patient should be warmly clad, and the legs enclosed in thick worsted stockings reaching nearly to the groins. After anæsthesia has been induced, the head is kept low, and a pillow placed beneath the buttocks, so as slightly to raise the pelvis. The bladder is carefully washed out with some bland antiseptic, such as a solution of boric acid, and about 6 ounces of lotion are left within it, in order not only to obliterate all folds of mucous membrane, but also to facilitate the seizure of the stone, and to prevent injury of the walls during the operation.

The lithotrite is then introduced. The best instrument to employ is Thompson's modification of Civiale's (Fig 441), the male blade of which is solid, and the female fenestrated. Other forms are sometimes used in which the female blade is solid, and is either the same size or larger than the male, in order to protect the walls of the bladder from injury. The male blade slides easily up and down a groove in the stem of the female blade, and after the stone has been seized the blades are forcibly pressed together by a screw action, brought into play by the mechanism in the handle, which can be put in and out of gear at will. It is absolutely essential that the instrument should be made of well-tempered steel, so as to prevent any risk of breaking during the operation. To introduce it some skill is needed, since the curved end is short, and consequently the handle must be well depressed between the legs, in order that the beak may pass under the pubic arch. The position of the stone is next ascertained by rotating the instrument, and using it as a sound, the blades are opened, and the stone caused to roll between them by a slight jerk of the handle. This is better than attempting to pick up the calculus by inverting the blades, and is less likely to injure the mucous membrane. If fairly grasped, the blades when screwed up crush it into several fragments each of which is subsequently dealt with in a similar fashion. If only the margin of the stone is gripped, the application of screw pressure may cause it to slip away, and the manœuvre must then be carefully repeated. When the surgeon is satisfied that the fragments are sufficiently small, the largest evacuator-tube that can be safely introduced is passed into the bladder. To effect this, it is sometimes necessary to incise the urethral orifice with a

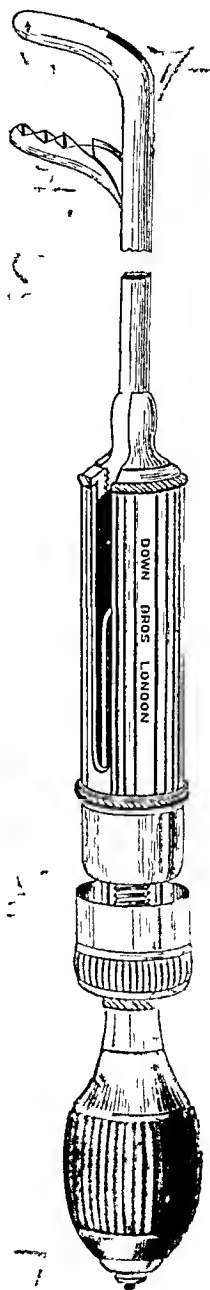


FIG 441 — THOMPSON'S MODIFICATION OF CIVIALE'S LITHOTRITE (DOWN BROTHERS)

bistoury in a downward direction. The evacuator is attached to the tube, and the bladder thoroughly washed out by alternate pressure upon, and relaxation of, the rubber bottle (Fig 442). By this means the fragments of the stone are collected in the glass receptacle which forms part of the apparatus. The washing is continued until no more fragments are heard or felt to rattle against the end of the tube. It is often necessary to reintroduce the lithotrite in order to crush some larger portions of the calculus still remaining, the old practice of withdrawing small fragments within the grasp of a lithotrite is to be condemned. It is scarcely necessary to re-sound the bladder after the efficient use of the evacuator. A certain amount of bleeding is indispensable from these manipulations, but it is not excessive in careful hands. Should, however, considerable

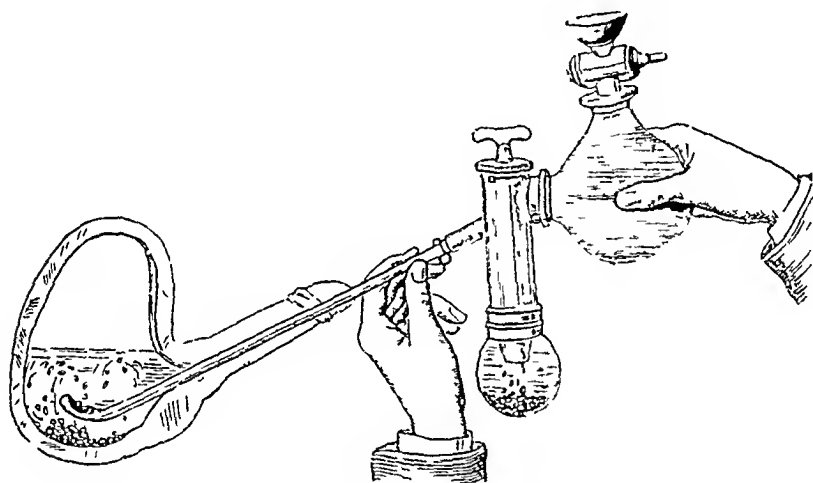


FIG 442 —EVACUATOR IN POSITION IN THE BLADDER

bleeding follow, the bladder is likely to become subsequently distended with clots, necessitating the use of a large-eyed catheter for their removal.

**After-Treatment** —The patient is placed in bed as soon as the operation is completed, and kept warm and quiet, and suitable measures must be taken to combat shock. The diet is restricted to fluids for a few days, whilst pain, if complained of, may be relieved by a little morphia. If all goes well, he may be allowed to get up at the end of the week.

Various *Sequelæ* may follow this operation. *Cystitis* results partly from mechanical causes, but more frequently from imperfect asepsis. The symptoms are usually subacute in character, and may pass away after a few days, but if of a serious type, considerable constitutional disturbance arises, and a large amount of viscid muco pus is excreted, whilst the urine becomes alkaline and ammoniacal. In such a case it is absolutely essential to wash out the bladder once or twice a day, as if left to itself the condition is very liable to spread up to the ureters, and may destroy the patient's life by suppurative pyelone-

*phritis* *Atony of the bladder* is occasionally induced, either by the operation or by a consequent cystitis, and is especially common in elderly individuals. It must be treated by regular and aseptic catheterism. When the patient's kidneys are already affected prior to the operation, an acute ascending pyelonephritis (p 1160) may be originated by it, perhaps leading to suppression of urine and death from uræmia.

**Suprapubic Lithotomy** was formerly looked on as a serious procedure with a high mortality, at the present time increasing experience has shown that the dangers were preventable, and that it may be considered a very successful procedure. The bladder is washed out, and 8 or 10 ounces of lotion left within it, the patient is then placed in the Trendelenburg-position, with the pelvis raised well above the head, the intestines being thus allowed to gravitate to the postero superior part of the abdomen, as soon as the abdominal parietes are opened, air finds its way into the connective tissue behind the symphysis (cavum Retzii), and the peritoneum is thus pressed back.

**Operation**—The pubes having been previously shaved, and the hypogastrium purified, an incision is made in the median line reaching from the top of the symphysis upwards for about 2 or 3 inches, the lower part of the linea alba is divided, and the retro-pubic cellular tissue opened up. The tense rounded outline of the bladder can now be readily detected with the finger, and a couple of lateral silk sutures or slings are passed through its walls so as to steady it and prevent its subsequent retraction. An opening is then made into it in the middle line from below upwards, through which the index finger is passed and the stone examined. Suitably curved lithotomy forceps are introduced, and the stone grasped and withdrawn. A careful examination of the interior of the bladder is then made, to ascertain whether any further calculi are present, as also to investigate the condition of the prostate, which may sometimes be advisably removed at the same time. The after-treatment of the wound differs with the condition of the bladder, if it is septic, a good-sized drainage tube is introduced, and the urine syphoned off, healing occurring by granulation in three to six weeks. If the bladder is healthy and free from sepsis, it may be closed by sutures, which only pass through the muscular and submucous coats, and thus when tied do not project into its cavity. The external wound may then be left open or closed, except at the spot where a drainage-tube or gauze wick is passed down to the vesical wound, so as to allow exit to any urine which may accidentally leak into the wound. The urine is either drawn off by a catheter at regular intervals, certainly not less than three or four times daily, or the bladder is drained by tying in a catheter.

**Perineal Lithotomy** is seldom required at the present day the procedure described as perineal cystotomy (p 1185) would be adopted. The finger is passed into the bladder and the stone located. It is removed by suitable stone forceps (Fig 444), or by

a scoop and the finger (Fig 443) Care must be exercised not to damage the structures at the neck of the bladder, or pelvic cellulitis may ensue, but this danger is little likely to arise, as the operation ought never to be undertaken when the stone is of large size

Formerly much importance was attached to the operation of *lateral lithotomy*, in which the stone was removed through a perineal incision which included the left lateral lobe of the prostate This

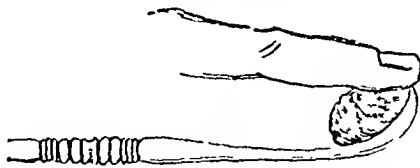


FIG 443 —LITHOTOMY SCOOP, AND POSITION OF FINGER IN EXTRACTING STONE

procedure is now entirely superseded, and need no longer be described

**Choice of Operation for Vesical Calculus**—At the present day lithotripsy has been brought to such a standard of excellence that there is no doubt as to the general rule which should be followed, viz, that *unless some contra-indication is present, all cases of vesical calculus should be treated by lithotripsy*

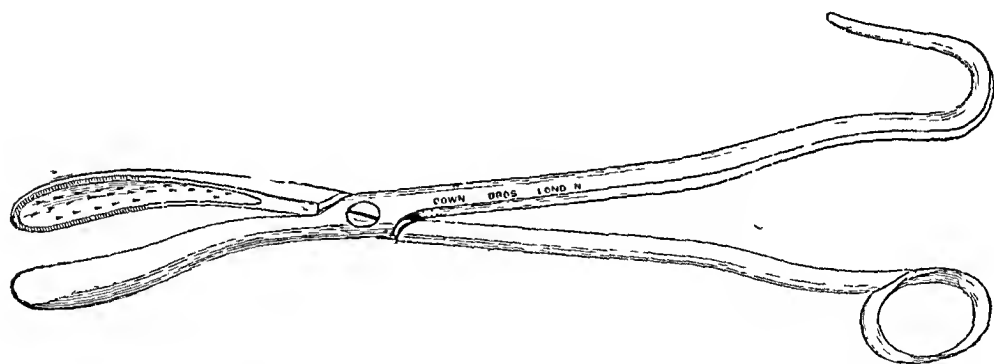


FIG 444 —FORCEPS USED IN PERINEAL LITHOTOMY (DOWN BROTHERS)

The **Contra-indications to Lithotripsy** are as follow (1) *Conditions of the Stone* If the calculus exceeds  $1\frac{1}{2}$  inches in diameter, it is not advisable to attempt lithotripsy, on account of the damage which may be inflicted on the vesical wall Moreover, some stones, especially those consisting of oxalate of lime, are so hard that no lithotrite can crush them Phosphatic concretions, on the other hand, are so soft that a lithotrite becomes clogged, and crushing is impracticable An encysted stone will also preclude lithotripsy on account of its fixed position There is no objection to dealing with multiple calculi by this means, but if only of small size, they may be removed by simply using the evacuator (2) *Conditions of the Urethra* The existence of an organic stricture, or an enlarged prostate, may

render lithotrity impracticable from the impossibility of passing large enough instruments, whilst false passages may make it exceedingly difficult. Excessive irritability of the urethra, as evidenced by the occurrence of severe rigors after instrumentation, may also render the operation unadvisable. (3) *Conditions of the Bladder*. The existence of severe cystitis or the presence of sacculi, as indicated by the cystoscope, will usually suggest the performance of lithotomy, whilst a contracted bladder, which will only hold a few ounces of urine, materially increases the dangers and difficulties of lithotrity.

**Suprapubic Lithotomy** should be undertaken under the following conditions: (1) Where the stone is too large to be dealt with by crushing, (2) where the stone is encysted, (3) where a stricture or enlarged prostate is present, and it is often feasible to remove the prostate at the same time. Suprapubic cystotomy is only absolutely contra-indicated by two conditions, viz., severe septic cystitis and contraction of the bladder.

**Indications for Perineal Lithotomy**—(1) Where serious cystitis and great irritability of the bladder are present, the incision facilitating the process of draining and washing it out, (2) a contracted and hypertrophied condition of the bladder, (3) when a calculus is impacted in the neck of the bladder.

**Calculus in Boys** is a common occurrence. It must be remembered that the bladder is rather an abdominal than a pelvic organ in children, and hence suprapubic lithotomy is particularly indicated. It has been shown, however, that lithotrity can be safely practised provided that suitable instruments are employed, and the external meatus is incised.

**Calculus in the Female**—As already mentioned, vesical calculus is very rare amongst women, owing to the shortness and greater size of the urethra, so that small stones passing downwards from the kidneys are easily voided. Phosphatic concretions are not uncommon, and are then formed around a foreign body usually introduced by the patient. Many of the symptoms are very similar to those in the male. **Treatment**—If the calculus does not exceed  $\frac{1}{2}$  to  $\frac{3}{4}$  inch in diameter, it can usually be extracted by dilating the urethra with the finger, the sphincter being also nicked in two or three places if necessary. It is never wise to divide the sphincter totally, as incontinence is almost certain to follow. For a somewhat larger stone lithotrity can be undertaken, whilst for those of really large size suprapubic cystotomy is the best procedure. It has been recommended to open the bladder through the anterior vaginal wall, and thus remove a stone, but this is scarcely desirable, for fear of the persistence of a vesico vaginal fistula.

### Affections of the Prostate

**Acute Prostatitis** arises most usually as a sequela of gonorrhœa, either in its acute or chronic stage, by direct extension backwards

of the inflammatory process, it is also occasionally met with as a result of stricture arising from the irritation of retained and decomposing urine, or from the passage of instruments. It is also said to be induced by the application of cold or damp to the perineum, as by sitting on cold stones or damp grass, but probably this has been preceded by bacterial invasion of the posterior part of the urethra. Suppuration follows in not a few cases, being due to the infection of the prostatic follicles with pyogenic organisms. Sometimes merely one or two superficial follicles are affected, causing what is termed a *follicular abscess*, occasionally the mischief extends much more widely, involving the whole of one lobe, or perhaps the whole organ, and constituting a *parenchymatous abscess*.

The **Symptoms** consist of deep seated pain referred to the neck of the bladder, with perhaps a sense of weight and fulness about the perineum. Micturition becomes frequent and painful, and defæcation may cause considerable distress. As the organ increases in size, the pain becomes more and more severe, and all movements of the body, as also the act of sitting, are increasingly difficult. On rectal examination the organ can be felt enlarged, hot, and tender. Suppuration is likely to follow, and retention of urine may be thereby induced. A follicular abscess bursts into the urethra spontaneously, or is ruptured by the passage of a catheter for the relief of retention, the opening, however, is sometimes of a valvular nature, and only a small portion of the pus escapes. The process may then continue to spread, and the pus may find its way into the rectum, or come to the surface through the perineum. In either of the latter conditions a rectal or perineal fistula is liable to result. Considerable constitutional disturbance is usually associated with this affection, whether suppuration occurs or not. The formation of a parenchymatous abscess is always attended with much more acute symptoms, both general and local. The organ is larger and produces more rectal irritation, a considerable quantity of pus may form, and suppuration may extend beyond the capsule into surrounding parts.

**Treatment**—The patient should be kept in bed on a restricted diet, and the bowels freely opened by saline purges, combined with small doses of antimony, and perhaps full doses of hyoscyamus. Local depletion may be undertaken by cupping the perineum, or by applying ten or twelve leeches to it. Hot hip-baths are also very valuable, and linseed-meal poultices may be placed on the perineum after the leeches have been removed. Extreme pain should be relieved by the use of *morphia* suppositories, and if the urine needs to be drawn off, a soft rubber catheter of small size should be used. If an abscess forms and is not opened by the passage of a catheter, or if the natural opening is of a valvular character, so that the cavity cannot completely empty itself, an incision must be made into it through the middle line of the perineum, being guided by a finger placed in the rectum, pus may not be reached until the knife has entered to a depth of about 2 inches. Urine will sometimes escape from this opening, and may continue to do so for some considerable

time If gonorrhœa is also present, suitable treatment must be adopted in order to check the discharge

**Chronic Prostatitis** is perhaps one of the most common causes of chronic gleet after gonorrhœa It is sometimes left as a sequela of an acute attack, or may arise as a result of stricture

The **Symptoms** produced by it are a sense of weight and fulness about the perineum, combined with irritability of the bladder, and pain referred to the extremity of the penis at the end of micturition, owing to the bladder contracting upon the hyperæmic and sensitive organ A glairy discharge of viscid material, similar in appearance to uncooked white of egg (*prostatorrhœa*), is often present, whilst fine threads of mucus are usually seen floating in the urine, being due to the formation of mucous casts of the prostatic ducts On examination through the rectum, the organ can be felt enlarged and tender, and the vesiculæ are usually in the same condition Chronic supuration may follow, the abscess bursting into the urethra or rectum, or pointing in the perineum

The **Diagnosis** from tuberculous disease can usually be made by careful attention to the history and physical signs

**Treatment** consists in counter-irritation of the surface of the perineum, as by blisters or iodine paint, care being taken that the reagent employed does not extend either to the anus or scrotum Belladonna suppositories may be of value, whilst the occasional passage of a cold metal bougie may do good In suitable cases, where a long-standing gleet is present with no suspicion of suppuration, a cure may occasionally be brought about by the administration of iodide of potassium, or of the liq ferri perchloridi (℥℥v or more, tds), combined with sulphate of magnesia The local application of a solution of nitrate of silver by a porte-caustique is also sometimes recommended, but we are not much in favour of such a proceeding Probably the best treatment consists in forcible dilatation of the prostatic urethra, as suggested by Oberlander, the follicles being thereby emptied of their secretion, massage of the prostate per rectum against a sound held in position may also be useful Should an abscess form, it is incised through the perineum

**Tuberculous Disease of the Prostate** is usually met with as a result of extension from similar disease in the epididymis, the seminal vesicles being also invaded, occasionally, however, it may arise as a primary affection In either case, it rapidly spreads to the bladder, and thence to the ureters and kidneys The prostate is found to contain caseous masses in the early stages, but later on these break down, leading to extensive ulceration, and sometimes the organ is riddled with ragged cavities The symptoms are those of irritability of the neck of the bladder, combined with pain referred, perhaps, to the end of the penis, or mainly noticed in the back or perineum Hæmaturia is occasionally produced, whilst pyuria is almost constant The urine is feebly acid or neutral, and, on examination of the pus which is deposited on standing, the tubercle bacillus may be detected



Rectal examination will demonstrate an irregular enlargement of the organ, whilst if the vesiculæ are invaded, they can also be felt

**Treatment** consists in attending to the general health, and the administration of tonics. Possibly, if the disease is not too extensive, benefit may be derived from scraping away the tuberculous tissue through a perineal incision

**Prostatic Calculi** are of unfrequent occurrence, being usually met with in cases of chronic prostatitis, especially that resulting from stricture of the urethra or previous attacks of gonorrhœa. They are generally multiple, and of small size, consisting mainly of carbonate of lime. They develop primarily in the glandular crypts, and may remain embedded in the organ, giving rise to but little inconvenience. When large and protruding from the gland into the urethra, symptoms of obstruction to the flow of urine are produced, whilst on passing a catheter or sound a distinct click or grating may be noticed. In the latter case, great irritability of the neck of the bladder is induced. Sometimes a number of them are found in a pouch or pocket, formed by the amalgamation of several of the crypts. It is in some instances possible to remove the calculi through the urethra, but more frequently a perineal incision is required

**Enlargement of the Prostate** (or, as it used to be termed, *scirrhous hypertrophy*) is a condition rarely seen under fifty years of age, characterized by a chronic persistent overgrowth of the organ, which results in interference with the act of micturition, and may finally destroy life by inducing secondary changes in the bladder and kidneys by prolonged backward pressure. As to causation, but little is known, it is not apparently attributable to excessive sexual indulgence. It may attain a considerable size, perhaps constituting a tumour as large as one's fist and weighing 200 grammes, the average normal weight of the prostate being about 18 grammes. It may be of hard or soft consistence, and in the latter case is extremely vascular. The vascularity varies from time to time, and the patient is liable to sudden attacks of congestion which aggravate the symptoms. On section the organ may appear to be homogeneous and of the same texture throughout, but most commonly it consists of a number of firm rounded masses, sharply defined, and held together by a certain amount of connective tissue. Outside these is an ill-defined layer of stretched (and sometimes atrophied) muscular tissue, containing a few glandular elements, but continuous with the stroma, and constituting the true capsule of the organ. Still further out is the extrinsic sheath, derived from the pelvic fascia (mainly recto-vesical), it consists of two layers, between which are the veins of the prostatic plexus

Histologically, an enlarged prostate consists of an overgrowth of the glandular tissue, sometimes diffuse, more frequently in the form of multiple adenomata, set in a connective-tissue basis developed from the prostatic stroma of muscle fibres. Cystic changes are not

unusually observed in these adenomata. Occasionally a few fibromyomata may develop, but they are decidedly uncommon.

The changes induced in connection with an enlarged prostate are numerous and important.\*

1 The prostatic sheath of pelvic fascia becomes thickened and condensed, thereby preventing any downward expansion of the organ, and directing its enlargement upwards.

2 The close connection between the capsule and the sheath, which is so marked a feature in the normal anatomy of the organ, is profoundly modified, so that it becomes easy to enucleate the gland in its entirety from its surroundings.

3 The relations to the bladder wall are also much altered. Normally, the sphincter (Fig 445, S V) is interposed between the

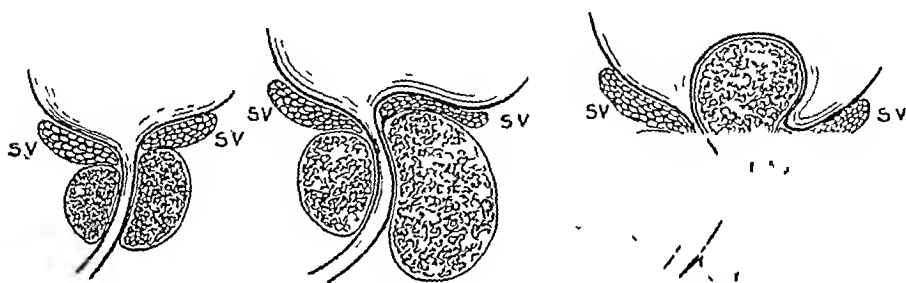


FIG 445

FIG 446

FIG 447

DIAGRAMS TO ILLUSTRATE RELATION OF THE PROSTATE TO THE SPHINCTER VESICÆ (S V)

In Fig 445 the prostate is supposed to be of normal size, and the sphincter lies above it. In Fig 446 the prostate is enlarged, but has no intra-vesical projection or 'middle lobe,' and hence the sphincter retains its normal relation. In Fig 447, the most common type of prostatic enlargement, a well marked intra vesical projection or middle lobe exists, the sphincter being displaced backwards by this development.

prostate and the vesical mucosa. As the gland enlarges, this relation may persist (Fig 446), and although the bladder base is raised up, the growth is extra vesical, and the sphincter muscle covers over the enlargement. More frequently, however, the gland, as it enlarges, insinuates itself between the sphincter and internal meatus, constituting an intra vesical enlargement (Fig 447). This is generally most marked in the middle line behind, constituting the so-called 'middle lobe'† (Fig 448), but it may involve the whole gland, which projects into the bladder as a collar-like enlargement around the meatus, whilst sometimes one or both of the lateral lobes are chiefly affected in this manner. The gland also pushes backwards between the

\* *Vide* 'The Surgical Anatomy of the Normal and Enlarged Prostate,' by J W Thomson Walker, *Med Chir Trans*, vol LXXVII.

† Students must remember that in the normal prostate there is no middle lobe, and that the structure thus named is caused by an abnormal overgrowth or projection from one of the lateral lobes.

seminal vesicles, which in time are displaced from their connection with the back of the bladder, and constitute a posterior relation with the enlarged organ. It is interesting to note that this overgrowth involves mainly, if not entirely, the upper part of the gland, and that the portion below the verumontanum is rarely affected, so that the openings of the ejaculatory ducts are not displaced backwards.

4 The changes produced in the prostatic urethra and neck of the bladder vary considerably in different cases. The length of the urethra is always increased, perhaps by 2 or 3 inches, or even more. Some amount of obstruction to the outflow of urine is universal. In rare

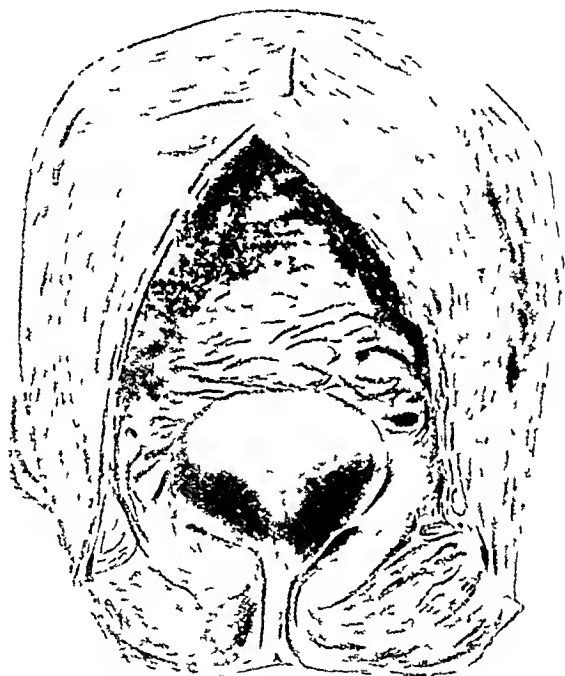


FIG 448 —ENLARGED PROSTATE WITH A LARGE INTRA VESICAL PORTION  
(FROM COLLEGE OF SURGEONS MUSEUM)

instances it may be due to an adenoma becoming pedunculated, and projecting downwards into the urethra as a polypus. Occasionally the base of the middle lobe becomes narrowed, probably as the result of constriction by a band of longitudinal muscle fibres passing down on either side from the ureteral orifice to the meatus, the middle lobe thereby becomes more or less pedunculated and may be moveable, constituting a ball-valve which determines retention, or else wedging open the internal meatus and causing incontinence. As a rule the outflow of urine is hindered by the 'prostatic bar' caused by the projection of the middle lobe, which also hinders the entrance of a catheter. When both lateral lobes are enlarged symmetrically, the lumen of the urethra is diminished from side to side, being narrow or chink-like instead of triangular, but its vertical measure-

ments are increased Asymmetrical enlargement, of course, displaces the urethra to one or other side

5 The *effect* of an enlarged prostate *on the bladder* is important The obstruction to the outflow of urine leads to increased expulsive efforts on its part, and consequently the wall becomes thickened and hypertrophied This involves the muscular fibres, which stand out prominently as rounded fasciculi, and the mucous membrane may project outwards between them as hernial protrusions, constituting saccules in which urine may stagnate and decompose, and even phosphatic concretions form

We have already alluded to the fact that in almost every case the enlarged prostate projects more or less into the vesical cavity, either as a collar-like mass around the internal meatus, or as one or more

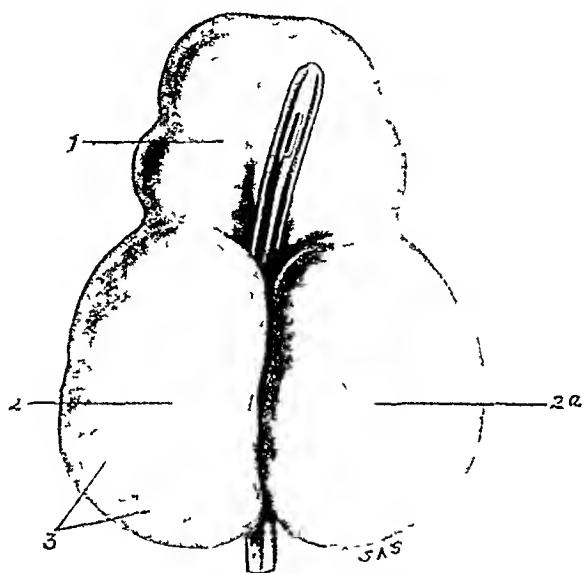


FIG 449 — ENLARGED PROSTATE AFTER REMOVAL BY SUPRAPUBIC OPERATION

The catheter indicates the position of the urethra 1, The so-called middle lobe or intra-vesical projection behind the internal meatus, 2 and 2<sup>a</sup> the lateral lobes, 3, indicates the nodular adenomatous masses which constitute the bulk of the swelling

rounded outgrowths This is necessarily associated with a pouching backwards of the lowest part of the bladder (*prostatic pouch*), which, being below the level of the meatus, does not become emptied during the natural process of micturition, and in which *residual urine* is therefore able to collect and remain

Cystitis is very likely to follow, either by infection from within or from the use of unsterilized instruments, and then the bladder wall becomes inflamed, ammoniacal decomposition of the urine follows, and renal complications may ensue (either hydronephrosis or pyonephrosis), which will determine a fatal issue

The **Symptoms** vary somewhat with the nature and position of the

enlargement The patient at first finds some difficulty in micturition, especially at the commencement of the act, straining often hinders rather than assists The stream is not necessarily smaller than formerly, but is projected with less force Gradually irritability of the bladder ensues, and the patient has to pass water very frequently, a trouble especially noticed during the night Some degree of pain and a sense of weight and fulness about the perineum are also experienced, whilst tenesmus, and even hernia, may be subsequently induced by the straining Intermittent attacks of increased-pain and difficulty in micturition occur from time to time, being generally induced by exposure to cold and wet, and presumably due to congestion of the prostate After lasting for a few days the more acute symptoms slowly disappear, if judiciously treated

As the obstruction increases, a certain amount of residual urine remains within the bladder after each act of micturition, the vesical muscles in time losing power and becoming atonic Well-marked distension and atony of the bladder ensue at length in neglected cases, the urine dribbling away and wetting the clothes, whilst decomposition of the retained fluid follows, and causes cystitis with increasing vesical irritation and muscular spasm The urine becomes alkaline after a time, containing muco-pus and phosphates, the result of chronic cystitis This, if untreated, is certain to lead to hydro-nephrosis and pyelonephritis The general health of the patient is slowly undermined by the constant irritation produced by this process, as also by septic absorption, and the final chapter may be ushered in by symptoms of uræmia from the mischief inflicted on the kidneys

Occasionally the early symptoms may pass unnoticed for a considerable time, the patient imagining that the frequent calls to pass water are good signs rather than evidences of disease In such cases the bladder may become over-distended, and the condition unsuspected until, owing possibly to some exposure to cold or over-indulgence in alcohol, complete retention is induced, and then, to the surprise of the patient, an enormous amount of urine is withdrawn on the passage of a catheter Priapism is sometimes a troublesome condition, and the effect of this on the moral sense may be very serious, and leads in some cases to acts of gross indecency

The **Diagnosis** of enlarged prostate is made partly by a consideration of the symptoms complained of, but mainly by an examination of the urethra and rectum The age of the patient, the increasing irritability of the bladder by night and day, the fact that straining hinders rather than helps the expulsive act, together with evidence of vesical distension—all these facts indicate that the seat of obstruction lies in the prostate A rectal examination is then instituted, and some idea gained of the size and condition of the organ, it must not be forgotten, however, that the size, as recognised by a finger in the rectum, cannot measure in any way the amount of obstruction to the passage of the urine, and, in fact, it often happens that where the gland does not feel especially large from the rectum, the obstruction is the greatest The careful introduction of a catheter will assist in

making the diagnosis, inasmuch as the barrier at the neck of the bladder is easily detected, and sometimes with difficulty passed

**Treatment**—All that is required at first is regular catheterism, in order to prevent the bladder from becoming over-distended, and thus the patient may often be taught to do for himself. To pass a catheter in a case of enlarged prostate is not always easy, owing to the fact that the middle lobe (Fig 447) projects across the urethra, and bars the onward progress of an instrument of the ordinary shape. The surgeon should therefore use either a catheter coudé or bicoudé (Fig 450), which consists of a soft, straight instrument of the usual French type, the end of which is bent or doubly bent at an angle, so as to enable it to ride over the obstruction, or he may employ an English gum-elastic catheter, the stylette of which is drawn out a little so as to increase its curve, or he may utilize the silver prostatic catheter, which is longer and more curved than usual, depressing it well between the thighs after clearing the pubic arch. Whichever method is adopted, no force is required, since with a little skill the

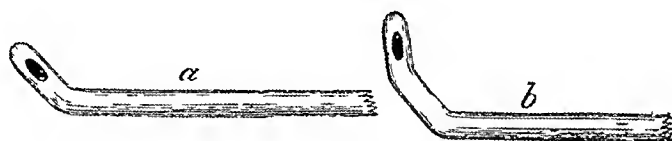


FIG 450—CATHETER COUDÉ AND BICOUDÉ

point of the instrument will pass round the obstruction and enter the bladder. Every precaution must be taken to ensure the efficient sterilization of all instruments employed, and it should be remembered that as a general rule large rather than small instruments will pass more easily.

During the first fortnight of catheter life the patient must be carefully guarded from cold and exposure, to avoid the occurrence of constitutional disturbance. Not unfrequently a certain amount of fever (to which the name of **Catheter Fever** was given by the late Sir Andrew Clark) is produced, which either passes off in the course of a few days, or may increase, together with symptoms of chronic cystitis, running on to a fatal issue at the end of three or four weeks. The origin of this condition is still somewhat doubtful, it may certainly arise from the absorption of micro-organisms or their products from the urethra, or from the use of impure instruments, but possibly reflex nervous disturbance plays some part in its production. The only treatment required in the simpler cases is to keep the patient warm in bed, to limit his diet, to administer quinine and opium, and to keep the bowels well open.

During the continuance of catheter life, the patient must be warned to live quietly, and abstain from all excesses, especially as regards eating and drinking, sexual excitement should be avoided, and horse-exercise forbidden, precautions must also be taken to ensure protection from cold and damp. The administration of alkalis is desirable

if the urine is highly acid, so as to diminish the irritability of the bladder

Under such a régime, it is possible that the patient may live in comparative comfort perhaps for years, the progress of the affection being entirely checked in some instances. In others, the patient suffers from intermittent attacks of congestion of the prostate, with increased pain and irritability of the bladder, and augmented difficulty in micturition. The introduction of a catheter is then very likely to cause bleeding, but a few days' rest in bed, hot baths, and the administration of ergot, usually bring about considerable improvement. If there is much difficulty in passing a catheter, it may be wise to tie it in for a time, or even suprapubic aspiration may be required. The progress of the case depends, to a large extent, upon the bladder remaining free from septic contamination, and the surgeon must realize and impress upon his patient that such is generally due to infection from without, and hence the most scrupulous care must be taken to sterilize all instruments before and after use. In cases where the relief given by regular catheterism is but temporary, and the irritability of the bladder or the amount of residual urine increases seriously, further measures are absolutely imperative.

In former editions of this book many methods of treatment were mentioned and their relative value indicated. At the present time we need only describe one method of treatment, *viz* **Prostatectomy**, which, though originally practised by McGill, of Leamington, a few years ago, has only been established as a successful and eminently practicable procedure for a few years, and that mainly by the energy of Mr P. J. Freyer. (There has been much discussion as to whether the whole prostate is removed from its fascial sheath in this procedure, or merely an intra-glandular enucleation performed.) This probably depends largely on the technique, either procedure is possible, and in the more exaggerated cases there is not much to choose between the two, as the enlarged organ is entirely adenomatous, and the intrinsic capsule is thinned and atrophic. The surgeon's aim, however, should be directed towards the complete removal of the organ, the line of cleavage being placed between what we have described as the capsule and the fascial sheath. Two methods of approach are possible, *viz*, from the perineum or by the suprapubic route. Personally, we are at one with the majority of surgeons in preferring the latter.

**Suprapubic Prostatectomy** — If there is much cystitis the bladder must be carefully prepared for a few days by keeping the patient in bed and washing it out with a mild antiseptic. At the time of operation it is again irrigated, and some 6 ounces or so of boric acid lotion left in it. The patient is placed in the Trendelenburg position, and the usual suprapubic incision made into the bladder. The vesical wall is by some anchored to the abdominal parietes by a deep silk worm gut stitch on either side, so that it shall not be unduly torn or displaced in the subsequent manipulations, this step is not essential, although the introduction of a silk sling through the bladder

wall on either side is desirable. The portion of the prostate projecting into the bladder is now carefully examined and its removal commenced. The index and middle fingers of the left hand (which is covered with a sterilized indiarubber glove) are introduced into the rectum so as to steady and push forwards the prostate. The right index finger tears through the mucous membrane behind the projecting median lobe or collar, thus passing between it and the displaced sphincter vesicæ. It will be found quite an easy matter to pass the finger round the enlarged organ and enucleate it, the larger the prostate, the more easily this is effected. In this procedure the ejaculatory ducts are torn across, as also the vessels which enter and leave the gland on either side. The urethra is either removed entirely, or the lower portion of it is detached and left behind. The prostate when free in its sheath remains either in one mass, or not unfrequently separates into two halves, which can be peeled off the urethra and removed separately from the bladder.

One fallacy must be mentioned, viz., that of dividing the mucous membrane over the median lobe with scissors, and thereby opening up a line of cleavage which runs inside the capsule between it and the adenomatous masses, which are thereby alone enucleated, the capsule being left behind. A complete prostatectomy should include the capsule and the many fragments of glandular tissue inclosed therein.

This enucleation is attended by remarkably little bleeding in the majority of cases, and even when at all free it can be quickly restrained by irrigating the cavity and bladder with hot saline solution through a catheter. A rubber tube is passed into the bladder through the lower angle of the wound, the upper end of which is closed by deep sutures, and provision is made for syphoning off the urine through the tube. Morphia is often needed subsequently to combat the pain and spasm that supervene, and it is advisably given as a suppository or as a starch and laudanum enema. The bladder is irrigated daily through a soft catheter passed *per methrium*, and small sloughs will escape for some days. As soon as the suprapubic wound is protected by a layer of granulations, the tube should be withdrawn, and a catheter tied in through the urethra. The patient is allowed up in an armchair as soon as possible to avoid pulmonary complications. Not unfrequently he will commence to pass urine naturally in about a fortnight or three weeks, and subsequently the function will be maintained in a normal fashion.

In **Perineal Prostatectomy** a median staff is passed, and then the membranous urethra and apex of the prostate are exposed, either by an antero-posterior or transverse incision in the perineum. The fascial sheath of the prostate is torn through or divided by the knife, and enucleation is then carried out by the finger, assistance being derived by pressing the bladder downwards from above the pubes. It is claimed that the urethra is less damaged in this procedure, but the advantages of the operation are not apparent to us.

If the patient refuses these operations, or if his general condition



prevents them from being undertaken with safety, and catheterism is insufficient to give relief to his symptoms, a ~~permanent~~ *fistula* either above the pubes or through the perineum must be established, necessitating the use of a portable urinal. This is effected by introducing a trocar and cannula into the bladder, and leaving it there until a sufficient track has been formed.

**Cancer of the Prostate** occurs in elderly men, but is not common, it is usually of a scirrhus type, though sometimes it is of a soft nature, in either form it early progresses beyond the limits of the capsule. The symptoms produced are those of obstruction to the flow of urine, together with pain, which may be very severe, and at a later date hæmorrhage. The progress of the disease is much more rapid than in senile hypertrophy. On rectal examination the hard mass is readily detected, whilst secondary deposits may be found in the lumbar and abdominal glands on palpating the abdomen. Occasionally phenomena referable to pressure on the abdominal vessels and nerves arise, and the symptoms of general cachexia soon manifest themselves. Palliative treatment alone can be adopted.

## CHAPTER XL

### AFFECTIONS OF THE URETHRA AND PENIS

#### Affections of the Urethra

**Congenital Malformations** — **Total Absence, or Occlusion**, of the urethra has been met with, the urine under such circumstances being sometimes retained, and leading to dilatation of the bladder, ureters, and kidneys, a condition rapidly fatal, even if the child be born alive. In a few cases the urachus remains patent, and a congenital urinary fistula is established at the umbilicus, whilst in others the cloacal condition persists, the urine passing into the rectum.

**Epispadias** is a deformity in which the urethra is partially or wholly exposed along the upper surface of the penis. According to Mr Henry Morris, it is not, properly speaking, a division or deficiency in the upper wall of the urethra, but in its floor, which has been transposed to the dorsum by torsion of the penis. 'It is thus, in fact, a hypospadias reversed, *i.e.*, upside down'. In rare instances, the external meatus is situated just above the glans, which is cleft and deeply grooved superiorly. More commonly the urethra opens at the root of the penis, just in front of the symphysis, and in such patients the organ is always rudimentary and stunted. Complete epispadias is only present when associated with eversion of the bladder (p 1178). The incomplete form has been treated with success by the use of reversed flaps dissected up from the side of the penis. For details of the operations on this and the following conditions, see larger text-books on operative surgery.

**Hypospadias**, or defective development of the lower wall of the urethra, is a much more common malformation than the foregoing. Three varieties are described. In (*a*) *hypospadias glandis* the opening of the urethra corresponds to the position usually occupied by the frænum, and is thus directed downwards instead of forwards. The prepuce in these cases is always voluminous, and hangs like a hood over the glans, which is bent down over the orifice. (*b*) *Hypospadias penis* is characterized by the urethra opening somewhere along the under surface of the body of the penis, which is often small and stunted. Considerable discomfort may arise in the act of micturition owing to the urethral orifice looking downwards, it is also sometimes so small as to require incision and dilatation. (*c*) Complete

hypospadias, or *hypospadia perinealis*, is a somewhat complicated condition, in which the lower wall of the urethra is defective as far back as the perineum, the scrotum being cleft, and thus resembling the vulva. The penis is always small, imperfectly developed, and bound down by adhesions between the scrotal segments, looking not unlike a hypertrophied clitoris. Under such circumstances it is not surprising that the sex of the child has been mistaken, and not a few cases are on record where it has been educated as a female until the age of eighteen or twenty. Non-descent of the testes is often associated with this malformation.

In the incomplete varieties, where the deformity is slight and the urethral opening well in front of the scrotum, no interference is necessary, but where it encroaches on the scrotum, causing inconvenience and discomfort, and threatening to prevent effective sexual intercourse in the future, the restoration of the urethra may be attempted by the use of reversed flaps obtained from either side, or from the redundant prepuce. In the complete form the penis must first be liberated from its adhesions and set free, the integument lining the scrotal cleft is then dissected up and turned inwards to form the posterior part of the urethra, whilst the lateral halves of the scrotum are brought together with sutures, the anterior portion of the urethra may then be dealt with as for the incomplete variety.

**Traumatic Laceration of the Urethra** usually results from violence applied directly to the perineum, as by falling astride a stile, fence, or beam; it has also been caused by severe jolting in the saddle, or by a kick in the perineum. In fractures of the pelvis it may be produced by a spicule of bone puncturing the canal, and the membranous portion is that generally affected. The whole circumference of the urethra may be involved, the two segments being entirely disconnected, or only a portion may be ruptured, and that most frequently the floor.

The **Symptoms** consist of pain in the perineum and shock, followed by great distension of the scrotum from hæmorrhage, whilst blood trickles from the urethral orifice. If the patient is able to restrain himself from passing water, and is successfully treated, no extravasation of urine results, since the lesion is below the sphincter vesicæ; if, however, he attempts to micturate, the urine finds its way into the perineal and scrotal tissues. Whether the rupture is complete or not, an organic stricture of considerable density is almost certain to follow, and great difficulty is subsequently experienced in keeping it dilated.

**Treatment**—In the slighter cases, where it is probable that the mucous membrane has alone been torn and there is no perineal swelling, the patient should be kept quiet in bed, and no attempts made at instrumentation. If urinary infection of the wound occurs and an abscess forms, it can be dealt with by incision at a later date.

Where, however, it is thought that the urethra is partially or wholly divided, no temporizing measures, such as tying in a catheter, even if that be possible, should be adopted. An incision ought to be made at once into the perineum so as to expose the divided ends of the urethra, which it is the surgeon's aim to unite. The blood-clot

is removed, bleeding points are secured, and if the ends of the urethra can be identified, a soft catheter is introduced into the bladder, and they are sutured together around it with fine catgut. When the ends are much torn, it is wise to cut away the bruised extremities so as to have clean, smooth surfaces to deal with. Under any circumstances the catheter must be kept in for five or six days, if possible, and subsequently an instrument should be passed every day for some time.

If a catheter cannot be introduced, or if extravasation has occurred, free incisions must be made into the scrotum and perineum to give exit to the blood and urine, and to expose the seat of injury. A catheter is passed as far as possible, and its point felt for, cut down on, and guided into the bladder, a prolonged attempt under anæsthesia may be necessary to accomplish this, and even then it is useless to attempt to stitch up the urethra, as the sutures are certain to cut out. Occasionally, and especially if treatment has been delayed, the swelling of the parts is so great as to render the passage of a catheter impossible. The patient must then be put to bed for a few days until the blood-clot has disappeared, the urine in the meantime escaping through the perineal wound, but as soon as possible another attempt must be made. When once the catheter is passed, it must be retained for several days, so as to establish the continuity of the tube.

**Foreign Bodies** are sometimes found in the urethra, usually consisting of a portion of a catheter, pipe stem, or in children a piece of slate-pencil. Their presence gives rise to partial or complete obstruction to the flow of urine, followed by ulceration of the mucous membrane, the formation of a peri-urethral abscess, or even extravasation. They are readily detected on the passage of a sound or catheter, and may be removed by suitable forceps if situated near the orifice. Should this fail, the urethra may be incised and the body extracted, a troublesome urinary fistula is apt to follow this proceeding, even when the wound in the urethra has been carefully sutured.

A pin is sometimes introduced voluntarily into the urethra, and is not easily removed, since it has usually been pushed in head-foremost. The following manoeuvre is necessary in order to remove it. The point is made to penetrate the floor of the urethra and skin by a sharp push on the head from behind. The body is pulled out until the head catches against the mucous membrane, and then the direction of the pin can be changed, so that the head presents at or towards the meatus.

**Impacted Calculus** is a not unfrequent cause of retention in children. It can usually be felt through the walls of the canal. The symptoms and treatment are much the same as for foreign bodies. When near the neck of the bladder, it should be pushed back into that viscus, if possible, and treated by lithotripsy.

**Simple Urethritis** may arise from a variety of causes apart from gonorrhœa, *e.g.*, the presence in the female of an irritating vaginal discharge, such as leucorrhœa, and possibly due to the *B. coli*. It also occurs after the passage of an instrument or of a calculus, and

is occasionally excited in gouty individuals by highly acid urine, charged presumably with spiculated crystals of uric acid. The symptoms are much the same as those of gonorrhœa, but the discharge is thinner in character, and on microscopical examination no gonococci are detected. The treatment consists in the administration of alkalies and saline purgatives, all forms of alcohol being interdicted. In more severe cases oleo-balsams may be prescribed, and even mild injections.

**Polypoid Tumours**, similar in character to the caruncle met with in the urethra of women, have been observed at the orifice of the male urethra. They are red, vascular, and sometimes exceedingly painful, and are best dealt with by excision, followed by the application of the galvano cautery, so as to stop the bleeding, which is always copious. If of large size, the base may be ligatured and the growth cut away.

**Epithelioma** of the urethra is usually secondary to some other malignant development in the neighbourhood, *e.g.*, of the prostate. Occasionally, however, it is primary, and then frequently the sequela of an old stricture. It constitutes a hard swelling of the urethra, which infiltrates surrounding parts, and there is usually some discharge of blood and pus from the meatus. Micturition is consistently painful, and the introduction of an instrument increases both the pain and bleeding; it generally passes easily, but the irregularity of the surface of the growth can be recognised. Amputation of the whole penis is usually required.

**Stricture of the Urethra**—By stricture of the urethra is meant a condition in which the onward passage of urine is hindered, owing to some change in the walls of the urethra, which prevents them from dilating. When at rest, the urethra is merely a potential canal, the walls of which are in complete apposition, and it is only converted into a tube when urine is passing along it. When, owing to some change in the structure of its walls, this functional dilatation is impracticable, the patient is said to suffer from stricture. Three forms of stricture are described, *viz.*, the *spasmodic*, *congestive*, and *organic*.

**Spasmodic and Congestive Strictures** frequently co-exist, although either congestion or spasm may be the predominant feature in any particular case. Thus, in acute gonorrhœa the mucous membrane often becomes engorged and thickened to such an extent as to interfere with the act of micturition. Spasm is the chief element under the following conditions: (1) When a patient, suffering from slight organic stricture, is exposed to wet or cold, especially after heavy drinking, (2) after operations on the rectum or spermatic cord, (3) as a result of catheterism, and (4) from perineal irritation of the urethra, as by a blow or kick in this region, or from prolonged riding on a bicycle with a badly-fitting saddle or on horseback. Temporary retention is the usual result of any of these conditions, and, as a rule, no treatment is required beyond placing the patient in a hot bath, and unloading the lower bowel by the use of a large warm enema. If such fails, catheterism will be necessary, and must be conducted with the greatest gentleness, owing to the congested and lacerable

condition of the mucous membrane Full-sized soft instruments should first be used, and will usually succeed, if not, a silver instrument must be substituted

**Organic Stricture** is the term applied to an undilatable condition of the urethra, resulting from the development of cicatricial tissue within its walls

The Causes of organic stricture are (a) The long continuance of a urethral discharge, or the frequent recurrence of this affection (b) The cicatrization of a urethral chancre, or of an ulcer caused by the impaction of a stone, or the contraction produced by the healing of a urethral abscess, may also lead to stenosis (c) The most intractable forms of stricture are those due to cicatrization after rupture or laceration of the urethral wall

The usual Situation is within the bulb, *ie*, just in front of the triangular ligament, but the orifice and body are not unfrequently affected It occurs in the membranous portion only as a result of traumatism, and never in the prostatic To find more than two strictures in any particular case is unusual, although three or four have been met with

Various terms are applied to a stricture according to the physical conditions present, thus, it is termed *annular*, if it involves the whole lumen of the urethra, *bridled*, if it affects only a portion of the circumference of the tube A *ribbon shaped* stricture is one in which a considerable extent of the wall is contracted (*ie*, as if a ribbon had been tied around the urethra) It is termed *toruous*, if the resulting passage is not straight, *indurated*, if the walls are very hard and thickened, and *resilient*, when the stricture, though readily dilated rapidly re-contracts The terms *impassable* and *passable* are applied to strictures through which, on the one hand, an instrument is unable to pass an instrument, or along which, on the other hand, urine cannot find its way, it is doubtful whether the latter condition ever occurs, whilst the number of impassable strictures met with by the surgeon diminishes with his experience and ability in passing instruments

The Symptoms of urethral stricture vary according to the case The patient generally complains of difficulty in the act of micturition, the stream becoming small, and perhaps forked or twisted It takes a longer time than usual to empty the bladder, and even when apparently successful a few drops of urine may trickle away, wetting the patient's clothes Irritability of the viscus follows, leading to frequent attempts to pass water at short intervals during the day and night The urine under these circumstances often becomes alkaline, and loaded with muco-pus and phosphates As the obstruction increases, more and more residual urine is left in the bladder, which may in time form a tense, rounded, dull swelling in the hypogastrium The quantity of urine trickling away also increases, so

that the patient's garments are always wet, giving him an unpleasant urinous odour. A certain amount of gleety discharge is present, whilst if the individual takes an excess of alcohol, or is exposed to wet and cold, complete retention may ensue. Sometimes the onset of symptoms is so insidious that such an attack of retention is the first marked feature in the case.

The **Pathological Conditions** arising from a stricture are best considered under the following five headings. (1) The *urethra anterior* to the stricture is usually in a perfectly normal state, although possibly the orifices of false passages may be seen. A few granulations are sometimes present, projecting at the commencement of the stricture. (2) The *stricture itself* is characterized by the development of fibro-cicatricial tissue immediately under the mucous membrane, and intimately adherent to it. It extends for a variable distance, and is often associated with a good deal of peri-urethral infiltration. (3) The *urethra behind the stricture* is dilated, and the mucous membrane velvety and friable, the orifices of the lacunæ and other glands are somewhat enlarged and more than usually evident, and perhaps ulceration may be present around them. In the later stages the inflammation may extend to the peri-urethral tissue owing to lymphatic absorption, or perhaps to the escape of a few drops of urine, a perineal abscess then results, leading subsequently to perineal fistulæ. When the obstruction becomes almost absolute, this portion of the urethra may give way, leading to extravasation of urine into the perineum and scrotum. (4) The *bladder* invariably manifests considerable changes in structure. At first the vesical wall undergoes a compensatory hypertrophy of its muscular elements and is thickened, in order to overcome the obstruction to the onward passage of urine (Fig 451). The lattice-work arrangement of the muscular bands becomes coarse, thickened, and evident, causing the vesical wall to assume a fasciculated appearance. As the pressure increases, the mucous membrane protrudes between the muscular fasciculi, giving rise to sacculation, it is also thickened and congested as a result of chronic cystitis, the superficial veins become varicose, and hæmaturia may be caused by their rupture, whilst ulceration may also occur. The urine becomes alkaline and decomposes, containing muco-pus and phosphates. It is likely to stagnate in any sacculi which exist, and may then determine the formation of phosphatic concretions, or the walls of the sacculi ulcerate, and after a time perforation and extravasation of urine into the cellular tissue lead to a fatal issue. Occasionally the bladder, instead of being thickened, is dilated and atonic, with very thin walls. (5) Consequent on the changes in the bladder, the conditions already described as hydro-nephrosis, pyonephrosis, or pyelonephritis may develop, partly as the result of the backward pressure, and partly from the extension of septic matter along the ureter to the pelvis of the kidney and calyces.

**Physical Examination** —The actual diagnosis of a stricture can only be confirmed by a careful physical examination of the urethra, which is usually made by the introduction of a full-sized catheter or a

solid bougie, *e g*, No 9 or 10 (English), so as to ascertain where the obstruction is situated. If this cannot be passed, smaller instruments, and even filiform bougies, are inserted until one is found which will enter the bladder.

A great variety of *catheters* is in use, in old days only metal instruments were obtainable, and even now the silver catheter is the favourite with many surgeons of eminence. In selecting such an instrument, care must be taken that it is suitably curved, and that the 'eye' is sufficiently large and bevelled inwards, so that no projecting rim lacerates the urethral mucous membrane. The great advantages of the metal instrument are that it is easily kept aseptic, and that the point can be located and thus guided more readily along the urethra. Of late years many different forms of flexible catheters have been introduced, and are now extensively employed, inasmuch as they give rise to less irritation than those made of metal. The objections to them are that the materials of which they consist are readily attacked and injured by antiseptics, whilst they are less easily directed through a stricture on account of their flexibility, it being impossible to know with certainty the situation of the point. Probably the best means of sterilizing a soft instrument is to expose it to the action of steam, which should be made to act not only on the exterior, but also inside the tube, many appliances to obtain this object have been devised. Amongst the best flexible instru-

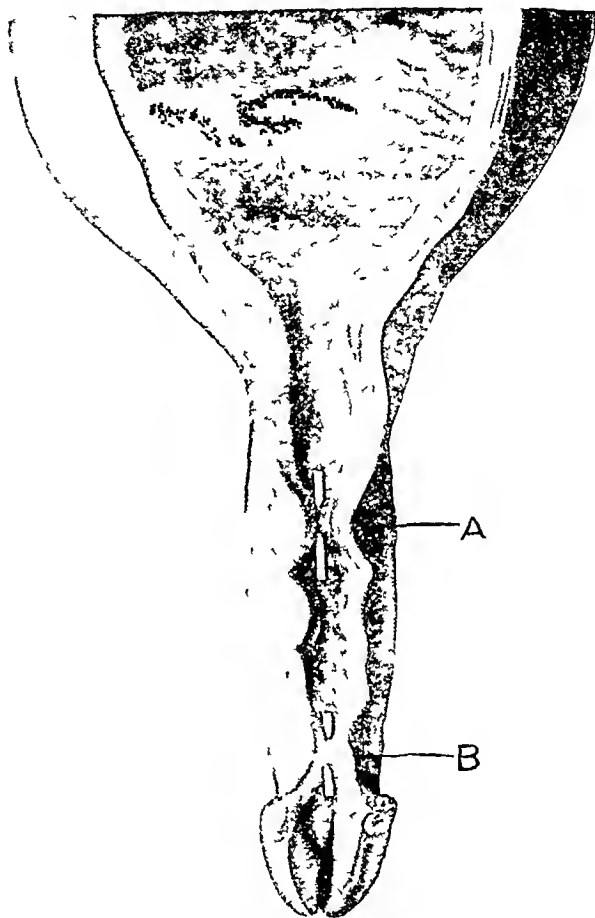


FIG 451 — STRICTURE OF THE URETHRA (COLLEGE OF SURGEONS' MUSEUM)

At A and B strictures are seen under which glass rods have been passed. The bladder is somewhat dilated, and its walls are thick and hypertrophic, and with commencing sacculation.



ments are the indiarubber or Jacques' catheter (the distal end of which beyond the eye should be solid and not hollow), the English or gum-elastic catheter, the French olive-headed or catheter-à-boule, and others made of silk-web coated with shellac, etc. Some varieties are now polished and prepared inside as well as out, and they should, if possible, always be selected.

*Bougies* or solid instruments are preferred by some surgeons for the examination and treatment of strictures. Those known as Lister's bougies are the best, consisting of solid metal rods, curved like catheters, the bulbous ends of which are three sizes smaller than the shanks, thus enabling each instrument passed to prepare the way for the next. Flexible bougies are also made, whilst for finding a way through a tight and tortuous stricture a filiform or a long graduated whip lash bougie, made of whalebone or catgut, may be employed, in the latter variety, the fine end is passed through the stricture, and coils up in the bladder, whilst the thicker portion is thus brought to bear on the stricture.

In order to introduce a silver catheter or bougie, the patient is laid on his back, the surgeon standing on his left side. The umbilicus should always be exposed, as also the upper parts of the thighs. The meatus and end of the penis are washed with a 2,000 solution of sublimate, as also the surgeon's hands. The catheter, which has been previously sterilized, warmed, and covered with some antiseptic oil or grease, is taken in the right hand, and inserted into the urethra, with the handle directed over the left thigh and slightly downwards. The point of the instrument is guided as far as the perineum, and then the handle is carried round to the middle line of the body towards the umbilicus, it is then raised to the vertical, the penis being held in the left hand, and gently depressed between the patient's thighs, the so-called *tou-de-maitre*. The catheter finds its way along the urethra into the bladder rather by its own weight than by any forcible action of the surgeon. The chief points at which difficulty may be experienced are (a) The orifice, which may be small and contracted, (b) the lacuna magna, which is avoided by keeping the point of the instrument against the floor, and (c) the opening in the triangular ligament, which is best entered by keeping the point against the upper wall of the canal.

Some authorities recommend that the patient should stand up, with the back resting against a wall or firm support, the surgeon sitting in front, and manipulating, it is said, with greater accuracy. The objections to this position are (a) The liability of the patient to faint, and (b) the existence of greater muscular tension than obtains in the horizontal posture.

When a flexible instrument without a stilette is used, it is passed by pressing the point on with a little rotatory movement until the bladder is reached, withdrawing a little, and pushing on again, if any obstruction is met. In some instances, however, the use of a stilette is absolutely necessary.

The chief Dangers of catheterism are as follow 1. A considerable

degree of *shock* is sometimes experienced, especially in sensitive individuals, and if an instrument has not been passed before. It may be obviated to a large extent by first introducing about  $\frac{1}{2}$  drachm of the 5 per cent solution of cocaine into the urethra.

2 *Hæmorrhage* may be induced by laceration or abrasion of the mucous membrane, even though no false passage has been made, it is best avoided by gentleness and the use of well finished instruments. In spite of these precautions, when the mucous membrane is soft and congested, and in many cases of stricture, some bleeding cannot be avoided. It is rarely sufficient to call for special treatment, but if very abundant may be arrested by the pressure of an instrument tied in or by injections of hazelne.

3 *False passages* are frequently produced in the treatment of strictures. The point of the instrument is most likely to leave the canal at some spot in the floor, travelling for a variable distance, according to the force employed, under the mucous membrane, occasionally re-entering the dilated urethra behind the stricture, which it avoids altogether, or perforating the posterior wall of the bladder by tunnelling under the prostate, an accident which can only occur in unskilful hands. The occurrence of a false passage is indicated by the sudden onward movement of the instrument, combined with pain and hæmorrhage, the point is usually deflected from the middle line; as is plainly seen by the obliquity of the rings at the end of the shaft, no urine comes unless the urinary passages are opened behind the stricture. On rectal examination, the instrument can be felt out of the middle line, and nearer the rectum than is normal, and in some exceptional cases has even been found in it. False passages are not necessarily matters of great importance, but when extensive may lead to peri-urethral suppuration and extravasation of urine, possibly followed by fatal results.

4 *Inflammatory phenomena* may be lighted up in the prostate, and acute epididymitis induced by extension along the vas deferens, these are almost always due to sepsis.

5 *Urinary Fever*, or, as it is sometimes termed, urethral or catheter fever, is always liable to develop as a result of the introduction of instruments. It may occur as a solitary rigor even in individuals with healthy urinary organs, but is much more frequently observed in those with damaged kidneys. As to its causation, there has been much discussion, but there can now be little doubt that it is essentially *septic* in origin. Possibly the instrument employed may be dirty, or the urethra itself contains septic material, especially in its deeper parts. It is quite sufficient for a slight abrasion to occur near the neck of the bladder, to allow of the absorption either of toxins or of bacteria, and then general phenomena show themselves at once. If merely toxic products are absorbed, probably a passing febrile condition, such as one or more rigors, will develop, with no more serious phenomena, but if bacteria find their way into the submucous tissues, they are likely to develop rapidly in the lymphatics, extending to the bladder and thence up the ureters owing

to the continuity of lymphatic supply, giving rise finally to pyelo-nephritis (p 1160). Formerly reflex congestion of the kidneys was thought to be an important factor in these cases, probably the congestion which occurs is due to the direct irritation of bacteria, and is not of nervous origin.

The *clinical manifestations* vary considerably, according to the character of the case and the type of infection. (a) The simplest form consists in the development of a single rigor, the temperature perhaps running up to 105° F, the patient shivers and feels very ill, complaining of headache, but when the temperature falls he soon recovers, and within a few hours is all right again. (b) Sometimes the temperature does not fall to the normal after the initial rigor, but remains elevated a few degrees for a day or two, and there may even be a repetition of the rigor. The patient, however, recovers perfectly, and no permanent harm is done. (c) In the more serious cases the symptoms of pyelonephritis supervene, and are very likely to prove fatal, the patient perhaps dying in seven or eight days. (d) General pyæmia may appear as a complication of the last condition. (e) In patients who are commencing the regular passage of catheters for enlarged prostate a series of phenomena develop, which have been already alluded to (p 1217), and though often mild, are of a similar nature. (f) Finally, suppression of urine may accompany any of the conditions alluded to above.

*Treatment* — Whenever it seems probable that the kidneys are damaged, the greatest care must be taken in order to avoid septic infection. The instruments employed, whether bougies or catheters, must be thoroughly sterilized, and it would also be well to irrigate the urethra with a mild antiseptic lotion. It is better to use soft instruments, if possible, rather than silver ones, as the latter give rise to more irritation than the former, and are more likely to abrade the mucous membrane.

For the single rigor following catheterism, the patient must be kept warm, plenty of hot diluent drinks given, and quinine (2 grains) administered. If the febrile symptoms continue, the skin and bowels are freely acted on, and a milk diet prescribed, although a certain amount of stimulant may be given if necessary, all operative measures must be avoided, unless it is essential to relieve obstruction, as they are almost invariably fatal. Should suppression of urine ensue, the loins should be cupped in the hope of relieving renal congestion, a free action of the bowels obtained by the use of watery purgatives, and the patient made to sweat freely, either by the use of hot-air baths or by the injection of pilocarpine. Uræmic symptoms may sometimes be relieved by copious and repeated intravenous injections of saline solution, which encourage diuresis and a watery diarrhoea, several successful cases have been recorded. It is possible that this condition might wisely be treated by incision into or decortication of the kidneys, in order to relieve tension.

The **Treatment of Passable Strictures** is conducted either by dilatation or by a cutting operation (internal or external urethrotomy).

Treatment by **Dilatation** is effected in various ways, according to the nature of the stricture and the urgency of the symptoms. Where the obstruction is not serious, and an instrument can be easily passed, *gradual dilatation* should always be employed, this consists in the use of instruments once or twice a week, steadily increasing in size until a No 12 is reached. If the intervals are too short, the urethra may become irritated, spasm be induced, and the lumen of the canal temporarily diminished in size, by keeping the patient quiet for a few days on a bland diet, and the bowels well open, the spasm disappears. In cases where time is an object, *rapid dilatation* may be undertaken by the passage of several sizes of bougie at one sitting, for this purpose, Lister's instruments are particularly useful. Where only a very small catheter can be introduced, and that with difficulty, *continuous dilatation* may be adopted by keeping the patient in bed, and tying in the small instrument for forty eight hours or more, at the expiration of which period a catheter several sizes larger can be substituted. This in turn may be tied in if the patient can bear it, but the presence of a catheter within the urethra for any length of time is not always tolerated, and may give rise at the end of two or three days to considerable constitutional disturbance and fever. *Forcible dilatation* is a plan which has now but few advocates. It consists in the passage of an instrument, the shaft of which is made in two portions, which can be separated from one another in such a way as to destroy the stricture either by distension or rupture of its substance. It is but little used, on account of the great tendency, when cicatrization is complete, to the formation of an even more intractable stricture than before.

By whichever of these methods dilatation is accomplished, it is essential that either the surgeon or the patient should subsequently pass an instrument through the stricture at first every week or two, and then at longer intervals, to overcome the tendency to re contraction which is ever present.

The **Treatment of Passable Stricture by a Cutting Operation** is conducted either by excision or by internal or external urethrotomy.

**Excision** is certainly the ideal treatment, the urethra being thereby restored to a normal condition. It has now been frequently undertaken and with great success in strictures of the deeper perineal portion of the urethra, it is not so satisfactory when the penile urethra is involved. Fully an inch of the tube may be excised, and the ends sutured together over a catheter. The corpus spongiosum must be detached from its surroundings to permit of this. Sutures are introduced in the upper wall first, then the catheter is placed in position, and the remainder of the stitches inserted.

**Internal Urethrotomy** is a valuable means of treatment when rightly employed, but in careless or inexperienced hands may be attended with considerable danger. It has been performed either by passing an instrument through the stricture, and dividing it from behind forwards, or by passing an instrument down to the stricture and dividing it from before backwards. The latter plan of treat-

ment, though recommended by some skilled authorities, is not an operation which commends itself to our judgment, inasmuch as it is almost impossible to gauge the amount of tissue divided. The former plan of incising a stricture from behind forwards is, of course, only called for under special circumstances, since if the urethrotome can be passed through a stricture, ordinary dilatation is in the majority of cases practicable. It is useful, however, (a) in the treatment of very old and dense cartilaginous strictures, as also (b) for resilient strictures, and (c) when the urethra is excessively irritable. It should only be employed when the obstruction is situated in the anterior two-thirds of the urethra, and never when septic contamination of the urine is present. Many forms of urethrotome have been devised, but perhaps the most useful is that known as Civiale's (Fig 452), which can only be used for a stricture which will admit the passage of a No 5 catheter. The end is bulbous, and contains a hidden knife, worked by means of a button in the handle. The instrument is passed through the stricture, the cutting blade projected, and by withdrawing it the cicatricial tissue is notched to such an extent as to allow a full-sized catheter to be

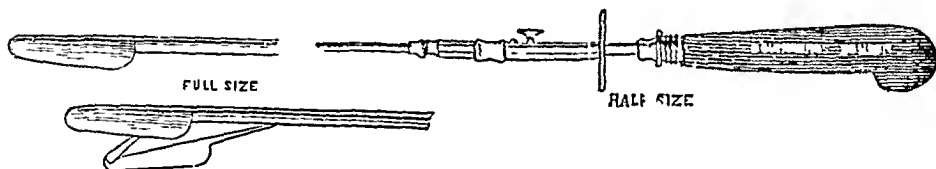


FIG 452 —CIVIALE'S URETHROTOME (DOWN BROTHERS)

inserted at once, and, if possible, tied in. Where the deeper part of the urethra is being dealt with, the incision should be made along the roof so as to avoid the bulb. Care must be taken not to cut beyond the limits of the cicatricial tissue, otherwise hæmorrhage, peri-urethral suppuration, or even extravasation of urine, may ensue. It is also advisable to sterilize the urethra as far as possible by washing it out with weak antiseptic solutions before operating.

**External Urethrotomy, or Syme's Operation,** is required under circumstances similar to those needing internal urethrotomy, if the stricture is situated in the posterior third of the urethra, but is chiefly employed where perineal fistulæ are present. It is performed by passing a special shouldered staff (Syme's, Fig 453), the distal end of which is small enough to traverse the stricture, and grooved in the middle line, whilst the shaft of the instrument is of larger size, and ends abruptly, so that the shoulder rests against the face of the stricture, the groove extends on to the larger portion for about  $\frac{1}{4}$  inch. The patient is then placed in the lithotomy position, and the surgeon, seated opposite the perineum, which is shaved and well purified, incises it in the middle line, carrying his dissection carefully downwards so as to reach the groove in the staff behind the stricture. The knife is then carried forwards to the anterior

extremity of the groove, and inasmuch as it extends on to the shaft of the instrument, the stricture is completely divided. Any fistulæ which exist are laid open into the median wound, and thoroughly scraped and purified. A full-sized soft catheter is then passed into the bladder, through either the penis or the perineum, according to circumstances, and retained in position for some days, the urine being syphoned off in the usual way, whilst the perineal wound, after all hæmorrhage has been stopped, is packed with strips of antiseptic gauze, and allowed to heal by granulation. The catheter is removed early or late according to the amount of general disturbance caused thereby, and subsequently a full-sized instrument can be passed into the bladder daily. Some surgeons have recommended the use of the so-called self-retaining catheters, in the hope of preventing urine from finding its way through the external wound, several varieties have been suggested, but they are of little practical value, since the escape of urine along the side of the instrument can never be totally prevented.

The Treatment of Impassable Stricture varies according to whether or not the condition is complicated with retention of urine.

If *no retention is present*, it is possible that the inability to pass an instrument is due to some temporary spasm or congestion induced by errors of diet or drink, or perhaps by exposure to cold. Hence the patient should rest in bed for a few days, his bowels be well opened, the diet regulated, and a mixture containing some alkaline purgative and tincture of henbane administered. Further attempts at instrumentation should then be made, if necessary, under an anæsthetic, and if the stricture still remains impassable, *Wheelhouse's operation* (Fig. 454) is indicated. This consists in incising the urethra in front of the constriction, tracing the passage backwards, and dividing it. A Wheelhouse's straight staff with a median groove and a blunt hook at the end is inserted down to the stricture, and the urethra opened just in front of it by cutting down on the groove. The staff is then twisted round, the upper end of the incision drawn up by the projection of the hook, and the sides of the urethra held apart with artery forceps. The orifice of the stricture is thus exposed, and granulations may often be seen projecting from it. A fine probe pointed director can generally be insinuated along the urethra through the stricture which is then divided. A full-sized instru-

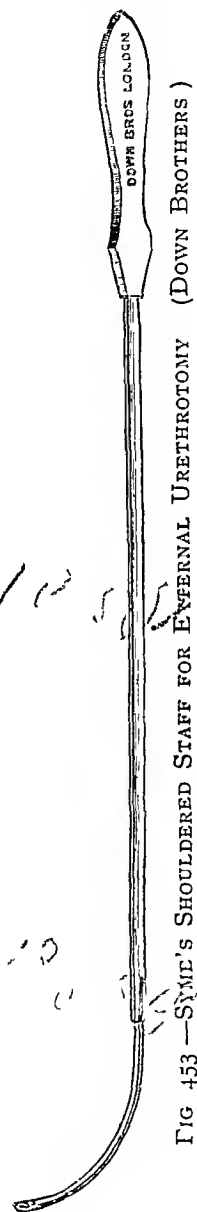


FIG. 453.—STYKE'S SHOULDERS STAFF FOR EXTERNAL URETHROTOMY (DOWN BROTHERS)

ment is passed into the bladder and retained for a few days, whilst the wound is allowed to heal by granulation

If retention of urine is present in a case of impassable stricture, no time must be lost. If seen at an early stage, and the symptoms are not urgent, the patient is given a hot bath, and the bowels are opened by a warm enema, whilst a moderate dose of opium or preferably a morphia suppository is administered. If the urine is not passed naturally in the bath, and the bladder is becoming distended, being felt in the lower part of the abdomen, suprapubic aspiration, or puncture with a trocar and cannula, should be undertaken, and temporary relief thus obtained. Probably, when tension has been removed from the posterior part of the

urethra, a catheter will be introduced without much difficulty. Failing this, aspiration may be several times resorted to, but it is generally wiser to open the urethra in front of or behind the stricture, and drain the bladder, since the risks of septic troubles, extravasation of urine, dangerous pressure upon the kidneys, and urinary infiltration along the lines of puncture, are thereby lessened.

**Cock's Operation, or Perineal Section,** is sometimes adopted when no guide can be passed into the bladder (Fig 455). The patient is placed in the lithotomy position, and the situation of the membranous urethra ascertained by inserting the index finger into the rectum. A median perineal incision is then made, and after dividing the cutaneous structures, the surgeon plunges the scalpel boldly in towards the apex of the prostate, guided by his finger in the rectum. He must keep strictly in the middle line, so as to avoid the impor-

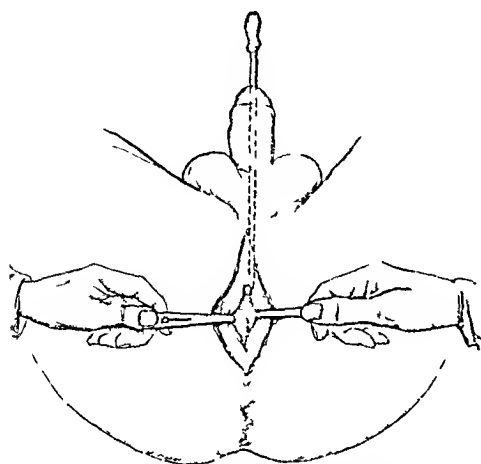


FIG 454 — WHEELHOUSE'S OPERATION FOR IMPASSABLE STRICTURE (BRYANT'S 'SURGERY')

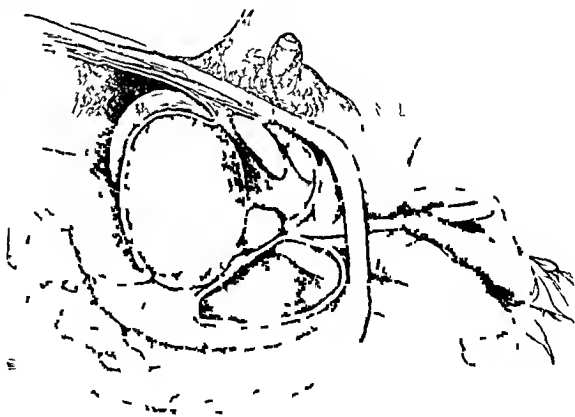


FIG 455 — COCK'S OPERATION OF PERINEAL SECTION (BRYANT'S 'SURGERY')

He must keep strictly in the middle line, so as to avoid the impor-

tant vascular and other structures which are so abundantly present in the perineum. As soon as the urethra is opened, a gush of urine often escapes, the upper urethral wall should not be damaged with the knife, for fear of opening up the deep pelvic cellular tissue.

This operation may be tolerably simple if the urethra behind the stricture is dilated, as is not uncommonly the case, but sometimes it is extremely difficult, especially if the urethra has been displaced laterally. If the stricture is not situated too far from the incision, it is always wise to complete the operation by dividing it, and a full-sized catheter can then be passed into the bladder, and the perineal wound allowed to granulate. If the stricture cannot be dealt with during the operation, and is of a dense cartilaginous nature, a tube is inserted into the bladder through the perineum, probably at the end of a few days the tissues will yield sufficiently

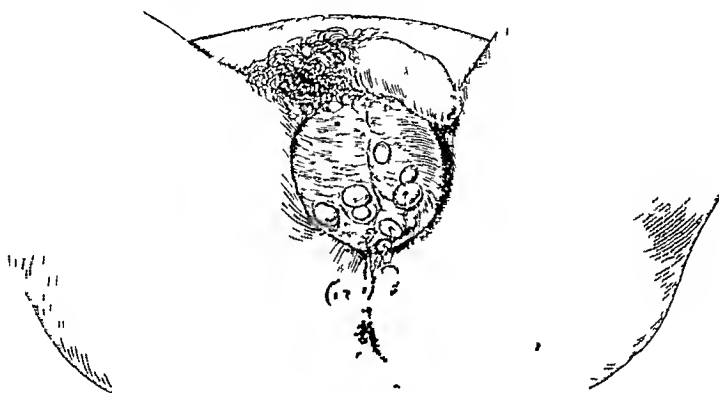


FIG 456 —PERINEAL FISTULÆ (BRYANT'S 'SURGERY')

to allow of the passage of a catheter, or Wheelhouse's operation can be subsequently adopted.

The chief complications of stricture other than those already mentioned are peri-urethral abscess, perineal fistula, and extravasation of urine.

A Peri-urethral Abscess is due either to a limited extravasation of urine, or to the absorption of septic material through an ulcerated surface. It is indicated by the formation of a hard, brawny swelling in the perineum or above the scrotum, which is tender to the touch. As it approaches the surface, fluctuation can be detected, and the skin over it becomes congested and œdematous. Constitutional disturbance and fever of an asthenic type are also present. Left to itself, it bursts and usually gives rise to a perineal sinus or fistula, discharging either pus or urine mixed with pus. One or many of these fistulæ may occur (Fig 456), and the openings are not limited to the perineum, but may also be found in the thighs, buttocks, or even the groins. In chronic cases, the scrotal or perineal tissues become infiltrated and of an almost cartilaginous consistency.

**Diagnosis** —Every abscess in the scrotum or perineum is not neces-



sarily associated with stricture, for simple irritation of the skin may lead to a superficial abscess, suppuration in the lacunæ, or Cowper's glands, may follow gonorrhœa, a prostatic or ischio-rectal abscess may point in the perineum, whilst the injury inflicted by the passage of instruments, or the existence of false passages, may lead to a similar result

The Treatment of a Perineal Abscess consists in the application of fomentations during the early stages, as soon as pus is present, it should be let out through a free incision, and it is often advisable to take the opportunity of dealing radically with the stricture by section at the same time. Perineal fistulæ can rarely be cured without operation, since, although the stricture may be completely dilated, the discharge of urine and pus continues. Under these circumstances Syme's or Wheelhouse's operation is the proper treatment.

Extravasation of Urine is a condition due to a solution of continuity of the urethral walls, allowing the urine to find its way into the perineal and scrotal tissues. It usually results from over-distension of the urethra behind a neglected stricture, during some violent effort at micturition, the patient experiences severe pain and a sensation as if something had given way in the perineum, followed by a feeling of relief. This, however, is of short duration, as it is soon succeeded by the local and constitutional effects of extravasation. Occasionally the onset of symptoms is more gradual, being preceded by a peri-urethral abscess, which bursts into the urethra, at each act of micturition the cavity becomes more and more distended with urine, finally the wall yields, resulting in diffuse extravasation. The same phenomena are produced in cases of traumatic laceration of the urethra if the patient attempts to empty his bladder.

The membranous urethra is almost always the site of the rupture, the urine finding its way subsequently through the anterior layer of the triangular ligament, and being guided towards the anterior abdominal wall by the arrangement of the fasciæ. The root of the penis, covered by its appropriate muscles, lies in an interfascial cul-de-sac, formed by the anterior layer of the triangular ligament above, and the deep layer of the perineal fascia (or fascia of Colles) below, these two layers are continuous, passing round the transversus perinei muscles, and are both attached laterally to the ischio pubic ramæ. Into this space the urine finds its way, after the anterior layer of the triangular ligament has yielded, and owing to the fact that its passage backwards and laterally is checked by the attachment of the fasciæ, it is necessarily forced forwards, infiltrating in order the perineum, scrotum, and body of the penis. If more extensive, it travels along the spermatic cords to the anterior abdominal parietes, its passage downwards into the thighs being prevented by the attachment of the deep layer of the superficial fascia of the abdomen to the fascia lata just below Poupart's ligament. In the most severe cases the urine may even find its way as far as the axillæ.

The Effects of extravasation of urine are always serious. Possibly, if the urine were pure and aseptic, part of it might be absorbed, but

even then prolonged infiltration of the tissues is likely to result in suppuration and sloughing. In cases of stricture, however, the urine is almost certain to be foul and alkaline, and hence wherever it travels it gives rise to a gangrenous cellulitis. The parts at first become infiltrated and brawny, but soon emphysematous crackling and putrefaction are observed, owing to necrosis of the cellular tissue. The congested and œdematous skin turns to a dusky purple or black colour, and finally gives way or separates, allowing exit to a mixture of pus, urine, and decomposing slough of a most offensive and penetrating odour. The superficial loss of substance may be so extensive as to lay bare both testicles, and even the body of the penis, or part of the anterior abdominal wall. The inflammatory process is necessarily associated with severe constitutional disturbance, at first characterized by high fever and a quick, bounding pulse, but later on the temperature may become subnormal, and the patient profoundly collapsed from toxæmia.

The Treatment consists in early and free incisions, so as to give exit to the urine and pus, and to prevent, if possible, the sloughing of the skin and subcutaneous tissues. Every part that the urine has infiltrated must be dealt with in this way, thus the perineum should be incised in the middle line, the scrotum is similarly divided, if need be, down to the urethra, the testicles being laid on either side, but, if possible, this should be avoided. The penis should be incised, if necessary, on either side of the urethra, and along the dorsal surface. It is often possible to expel a large portion of the urine, especially in the scrotum, by firmly squeezing the infiltrated tissues. A full-sized catheter must be passed into the bladder, and to effect this the urethra has often to be laid open and the stricture divided, perineal drainage is always preferable for these cases. The parts should be subsequently dusted over with iodoform, and dressed with warm antiseptic applications, *e.g.*, a charcoal or carbolic linseed poultice, or boracic fomentations. Frequent hip-baths should be employed, and, if practicable, a continuous sitz-bath would be the very best means of treating the case. As soon as the wounds become clean, they should be dressed in the ordinary way to allow them to granulate. The general health of the patient must of course be attended to, plenty of easily assimilated nourishment, stimulants, and quinine being administered.

**Urinary Fistulæ** are most commonly found in the perineum, scrotum, or body of the penis. They usually result from perineal suppuration in connection with a stricture, but are occasionally due to other causes, *e.g.*, a lacunar abscess after gonorrhœa, or a prostatic abscess. They vary much in size and number, when the result of a stricture, many may be present (Fig 456), and great infiltration of the surrounding tissues is usually produced. The Treatment of perineal fistulæ has been already in measure described, external urethrotomy being necessary if a stricture exists. Occasionally the perineal wound does not close after such an operation, even when the stricture has been divided, the edges of the fistula

should then be pared, and the wound brought together by deep quilled sutures. A catheter should be kept in the bladder for a few days, and the urine regularly drawn off after its removal.

When of small size, and situated either in the perineum or the penis, cure may be determined by cauterizing the passage either with a probe coated with nitrate of silver or by a galvano-cautery, but in other cases some form of urethroplasty is necessary.

### Affections of the Penis

**Phimosis**, when complete, is a condition in which the prepuce is so long, and the orifice so narrow, that it cannot be retracted behind the corona. It is usually **Congenital** in origin, and may exist to such a degree as to render micturition impossible. More frequently the opening is a very small one (pinhole prepuce), permitting micturition, but leading to irritability of the bladder from the obstruction. In such cases the prepuce is usually adherent to the glans, and considerable irritation is caused by the retention of the smegma secreted by Tyson's glands, this may collect and become so inspissated as to give rise to definite concretions. The child pulls at the foreskin, owing to the itching produced, and thus the symptoms of vesical calculus may be simulated. Attacks of balanitis are also frequent, and should the prepuce be withdrawn, paraphimosis is almost certain to follow. If allowed to remain untreated long enough, distension of the bladder, and even hydronephrosis, may supervene. Not only is this condition in itself a cause of irritation to the individuals affected, but it is often provocative of masturbation, moreover, it is certain to aggravate the symptoms of venereal disease, and there is but little doubt that it acts as a predisposing cause to epithelioma of the penis. Phimosis also occurs as an **Acquired** condition, resulting from the cicatrization of venereal sores.

The **Treatment** of phimosis consists in circumcision. Other methods have been suggested—*e.g.*, dilatation of the prepuce, and merely slitting it up—but they are not satisfactory.

**Circumcision** should always be performed on children with a long prepuce within the first year of life, since at that time the parts are but slightly developed, the operation is a trifling one, and but little inconvenience is subsequently experienced, the longer it is postponed, the more troublesome does it become. The best method of operating is as follows. The dorsal aspect of the prepuce is put on the stretch by grasping it on either side of the median line with a pair of catch forceps, a director is then introduced between it and the glans, and held exactly in the middle line, and the prepuce slit up with a curved pointed bistoury or scissors. The lateral halves are now separated from the glans, adhesions, if necessary, being broken down, this must be very thoroughly attended to, so as to enable all retained smegma to be removed, and the corona glandis defined. The redundant preputial tissue, both skin and mucous membrane, is cut away on each side by scissors, special attention being directed

to the removal of sufficient tissue on the under side to prevent the unsightly projection so frequently seen just below the frænum. In adults several vessels will bleed and require to be ligatured, especially that in the frænum, but in a child the hæmorrhage is trifling. Having carefully trimmed up the edges, and snipped off all ragged corners so as to render the margins of the wound regular, catgut sutures are inserted to prevent any raw surface being left exposed, in children only a few are required, but possibly a considerable number in adults, a continuous suture should never be employed. The wound is dressed with strips of gauze or lint dipped in carbolic oil, and around this, again, a wisp of antiseptic wool, no bandage or tape is required. In adults considerable after-trouble may be experienced from nocturnal erections, which may be so marked and prolonged as to tear through the stitches, to control this the patient's bowels should be freely opened, and he should be kept on a low and unstimulating diet and bromide of potassium or other sedatives administered. The stitches are usually removed at the end of five days, and the parts are then dusted over with a mixture of powdered boric acid, zinc oxide, and starch, so as to reduce their sensitiveness.



FIG 457 —REDUCTION OF PARAPHIMOSIS

When a phimosed prepuce is completely retracted, the patient often finds it impossible to replace it, thus giving rise to a condition known as **Paraphimosis**. It is due to the narrow orifice of the prepuce getting behind the corona, and is characterized by great œdema and congestion, not only of the exposed mucous membrane, but also of the glans itself. If left untreated, ulceration takes place along the line of constriction, and the parts become fixed in their deformed position, the vessels sooner or later accommodating themselves to the new conditions, and the œdema slowly disappearing. In some cases sloughing of the glans may occur.

**Treatment** consists in forcible replacement of the prepuce. This is accomplished by grasping the penis between the first and second fingers of each hand, and compressing the glans penis with the thumbs so as to empty the vessels and diminish the amount of œdema present, and thus reduce its size (Fig 457). At the same time the fingers draw the prepuce forwards, and thus finally reposition is effected. When the œdema of the prepuce is very marked, it should be punctured in several places to permit the escape of serum and diminish the tension, previous to reduction as just described. In more advanced cases reposition becomes impossible, and then the narrow constricting band caused by the orifice of the prepuce must be divided on the dorsal aspect. This will free the parts, which can be subsequently

drawn forwards, and after the œdema has been reduced by applying *lotio plumbi* for a few days, circumcision may be advantageously undertaken

**Balanitis**, or inflammation of the glans, may be simple in nature, arising from want of cleanliness in a person with a long foreskin, but more frequently is associated with gonorrhœa or soft chancres. The under surface of the prepuce is often involved, and then the term *Balano-posthitis* is sometimes applied to it. A muco-purulent or purulent discharge escapes from under the prepuce, which is often swollen and œdematous. Occasionally, when a considerable degree of phimosis exists, the under surface of the prepuce may become ulcerated, and even perforated, whilst in very neglected cases, and especially if phagedena is present, the prepuce will slough, and allow the glans to protrude, usually through its upper surface.

**Treatment**—In simple cases, all that is required is to cleanse the parts thoroughly by washing beneath the foreskin and then apply lead lotion on lint between the glans and the prepuce, but when there is much discharge, and the foreskin is long and swollen, or if perforation is threatening, the prepuce must be slit up, and, after the parts have been restored to a healthy state, the redundant tissues should be cut away by a modified circumcision.

For **Soft Chancre and Syphilis**, see pp 136 and 137

**Herpes** not uncommonly affects the prepuce and glans. It may result from simple local irritation, more especially in gouty individuals, but is most frequently seen in patients who have suffered from syphilis, and is then likely to be somewhat intractable. It manifests itself as a crop of small vesicles on a hyperæmic base, which become abraded, leaving a number of small ulcers. It is preceded by pain of a neuralgic type, and accompanied by much itching and irritation. The only treatment required is to keep the parts clean, and dust them over with powdered oxide of zinc and starch. In the majority of cases the disease lasts from a week to ten days. During the healing of the herpetic ulcers, a patient is very liable to be inoculated with the virus of either the soft chancre or syphilis if he exposes himself to the risk of infection.

**Warts** often arise on the penis in the shape of red, vascular excrescences, usually pedunculated, and sometimes of considerable size. They are met with most frequently as a sequela of gonorrhœa, and must be carefully distinguished from mucous tubercles. They should be treated by snipping them away with scissors, and cauterizing the base with a galvano-cautery.

**Horns** are also occasionally seen arising from the body of the penis. They are of the usual sebaceous type, as described at p 404, and should be excised.

**Epithelioma** of the penis rarely arises except in patients who are the subjects of congenital phimosis or possess long foreskins, and hence it is stated that the disease is unknown amongst the Jews. It usually commences in the sulcus behind the corona glandis, and rapidly spreads to the surrounding parts, manifesting itself either as

an irregular, papillated, wart-like outgrowth, or as a diffuse infiltration, ulcerating early, and leading to considerable destruction of tissue (Fig 458). At first the tumour is mainly beneath the prepuce, which becomes distended, producing a sanious discharge, which contains epithelial cells as well as pus corpuscles, but as the case progresses, the prepuce itself is attacked, and even perforated. Later on the body of the penis is invaded and, owing to its great vascularity, the disease makes rapid progress. The inguinal glands are early affected, but when the body of the penis is involved, the lumbar glands are also implicated.

The **Diagnosis** of epithelioma from warts is easily made by contrasting the infiltration of the base produced by the former with the soft and normal condition of the glans in the latter condition.

The **Treatment** of epithelioma consists in amputation of the penis whenever the disease is sufficiently limited to lead to the hope that it can be eradicated. When confined to the distal end of the organ, the operation may possibly be performed through the body, but it is much more logical and more dicta to remove the whole organ.

*Amputation through the body of the penis* is an operation of but little difficulty. A short flap is reflected from the dorsum, and the corpora cavernosa cut through, the urethra and remaining portions of the organ being removed at a lower level. Bleeding is then arrested by securing the divided vessels, five ligatures are usually required, viz., one for the artery to the corpus cavernosum on either side, one for each dorsal artery, and one for the artery to the septum. The urethra is then isolated, and passed through an opening made in the upper integumental flap. It is split along its upper wall, and secured by sutures to the margins of the opening, so as to prevent subsequent retraction, the flaps are then united by stitches.

*Amputation of the whole penis* is a more serious, but very successful, operation. The patient is placed in the lithotomy position, and the perineum, after being shaved and purified, incised freely in the middle line. The corpus spongiosum is traced backwards, and divided at such a level as to allow the mucous membrane lining the proximal portion of the urethra to be stitched to the skin at the posterior angle of the incision. The corpora cavernosa are freed



FIG 458—EPITHELIOMA OF PENIS  
(KING'S COLLEGE HOSPITAL MUSEUM)

from their connections, and separated at their origins from the ischio-pubic ramus by the knife or suitable raspatories. An elliptical incision is then made round the root of the penis, the dorsal vessels are divided and secured, and the suspensory ligament cut through. The penis can then be drawn forwards, and by a few final touches of the knife completely removed. All bleeding points are ligatured, and the anterior wound closed by a continuous suture in the middle line, a drainage-tube being placed in the perineal portion for a few days. The results of this operation have, on the whole, been very satisfactory, and by the use of a suitable contrivance the patient need not assume the sitting posture in order to micturate. He will require to carry about with him a small metal funnel, bevelled to fit the perineum, and with a spout directed forwards. We have seen an excellent one extemporized by a patient from the rose of a watering-can, the perforated top having been removed and the edges smoothed and bevelled.

## CHAPTER XLI

### AFFECTIONS OF THE TESTIS, CORD, SCROTUM, AND SEMINAL VESICLES

**Congenital Affections of the Testis**—It is scarcely necessary to state that the testicles are not developed in the scrotum, but from the posterior wall of the abdominal cavity, so that they lie at first behind the peritoneum close to the kidneys. The body of the gland arises from the so-called genital ridge, which is covered by columnar epithelial cells, and lies to the mesial side of the Wolffian body. The vasa efferentia are developed from the tubules of the latter structure, coming into relation at a later date with the seminal tubules, the vas deferens is formed by the Wolffian duct.

Occasionally the body of the testis is entirely absent, whilst in a few cases it is on record of absence or deficiency of the vas. Very rarely two testicles have been developed on one side, and have both found their way into the scrotum (*polyorchism*).

The passage of the testis from the abdominal cavity to the scrotum takes place at about the end of the eighth month of intra-uterine life. 'The gubernaculum testis is the active agent in bringing about the descent of the testis. This is a band of involuntary muscular fibres which traverses the inguinal canal, and establishes important connections both within and without the abdominal cavity. Below, three in its attachments of the gubernaculum may be recognised, viz (a) to the abdominal wall, (b) to the pubis, (c) to the bottom of the scrotum. Above, the gubernacular fibres are chiefly connected with the testicle, but many of them are also attached to the peritoneum on the posterior wall of the abdomen. By the traction which the gubernaculum exerts on the testicle, the descent of that organ is brought about. By the portion attached to the abdominal wall the testicle is pulled down to the internal abdominal ring, the pubic portion drags it through the inguinal canal, whilst the scrotal part finally leads it into the scrotum.

'The formation of the processus vaginalis is accounted for in the same way. Some of those gubernacular fibres which are inserted into the peritoneum drag down the peritoneal diverticulum which lines the inguinal canal and scrotum, and prepares the way for the testicle' (Cunningham's 'Manual of Anatomy,' vol. 1, pp. 426, 427).

Two chief forms of malposition of the testis are described, arising either from its incomplete or abnormal descent.

1. **Incomplete Descent or Retention of the Testis**—The testis may remain in the abdominal cavity attached to the abdominal wall by a mesorchium (*retentio abdominalis*), more frequently, it is found just within the internal abdominal ring (*retentio iliaca*) but most commonly it occupies the inguinal canal, or lies just outside of it (*retentio inguinalis*). The organ in the latter position is freely mobile, being readily pressed up towards the abdominal cavity. The Causes of this condition must be looked for mainly in some abnormal attachment of the gubernaculum, or possibly in the existence of intra-uterine peritonitis. Less



commonly a contracted condition of the external abdominal ring or an unduly large epididymis, may determine its occurrence.

The condition is easily recognised by the absence of the testicle in the scrotum, and in the inguinal variety the organ can usually be detected as a small movable swelling about the size of a horse bean, giving the characteristic testicular sensation on pressure. The scrotum on the affected side is imperfectly developed.

In any of these varieties a late descent of the testis may occur, usually accompanied by a congenital hernia, possibly of an interstitial type.

**2 Malposition of the Testis**—Two distinct forms are described. (a) *Ectopia Perinealis*—In this variety the testis finds its way into the perineum, slipping along the groove between the thigh and the scrotum. It may exist as a congenital condition, being then due to the contraction of an accessory band of gubernaculum fibres, or it may happen in consequence of a late descent of the testicle, owing to atrophy of the scrotum. It always causes considerable inconvenience to the patient, especially on sitting or riding. (b) *Ectopia Cruralis*—The testicle here lies on the inner side of Scarpa's triangle, in the region of the saphenous opening. It is said to escape along the crural canal, but more probably it passes down the inguinal canal as usual, and then finds its way over Poupart's ligament to this situation, guided by a second accessory band of gubernaculum tissue. When, as not uncommonly happens, a congenital hernia also exists, it may travel outwards to the inferior superior spine, being directed there by the arrangement of the fasciæ, as in a femoral hernia (extra-peritoneal interstitial hernia, p. 1071).

In cases of retained or misplaced testis the spermatogenic function of the organ is rarely developed, or at most merely for a year or two about the age of twenty. Pain is not unfrequently complained of, coming on in bouts which last for a short time and then disappear, probably due to slight injuries or torsion. Fibrosis of the testis follows in time, and total degeneration is the ultimate outcome. If only one organ is affected, but little harm follows, but if both are involved, the individual is probably sterile.

**Complications of a Retained or Misplaced Testicle**—Any of the conditions to be described hereafter in this chapter may involve a retained or misplaced testicle, just as if it were in the scrotum, and give rise to considerable trouble, especially when the organ is lying in close proximity to the peritoneum. A testis misplaced or retained in the inguinal canal is much exposed to injury, and a subacute traumatic orchitis often occurs. It is stated that such organs are very prone to become the seat of malignant disease at a later period of life, but the accuracy of this statement is a little doubtful.

**Treatment**—Taking into consideration the discomfort occasioned by this condition, as well as the risk arising from the tendency to malignant disease, there can be little doubt that the best method of treatment is ~~the removal of the testicle~~. Many operations have been devised with the idea of placing the organ in its normal position in the scrotum, but the majority of such methods have proved useless, owing to the defective length of the spermatic vessels and cord, moreover, the traction and handling required to draw the organ down into the scrotum may determine the occurrence of fibrotic changes, even if they are not already present. Some authors advise the replacement of the organs in the abdominal cavity in patients before the age of twenty three, but it is doubtful whether much value is to be attached to such a suggestion.

Another condition met with congenitally is **Inversion** of the testis, the epididymis lying in front, and the body of the organ behind. It is of no clinical significance, except that in careless hands it may be injured whilst tapping a hydrocele.

**Torsion of the Spermatic Cord** results in acute strangulation of the testis. The cause still remains unknown, but several of the cases recorded have been associated with late descent of the testicle, and others have been attributed to twists and strains. The symptoms are tolerably characteristic: the patient complains of an acute sickening pain in the testis which persists until gangrene has supervened, and may then disappear, it is accompanied by a certain amount of pyrexia, and the appearance of a tumour, either in the inguinal region or in

the scrotum The testicle, slightly enlarged, is felt below, and above it a larger mass, consisting of the twisted cord and the congested and swollen epididymis In some cases the latter swelling has been crepitant, owing to the development of gases due to its putrefaction The condition is very likely to be mistaken for a strangulated hernia, which it closely resembles, but the presence of fever, and the absence of abdominal distension and of faecal vomiting, are important distinctive signs, moreover, constipation, though often present, is never absolute If the testis is situated in the scrotum, the cord and inguinal canal are found to be clear, whilst if in the canal, the affected side of the scrotum is empty The only Treatment possible is exploration and removal of the inflamed or gangrenous testis and cord, unless the case is seen very early, when it may be feasible to untwist it

**Injuries of the Testis and Cord** — **Contusion** is a very common form of injury It arises from blows, kicks, squeezes, and the like, and is always associated with immediate pain of a most sickening and intense character, which is not only experienced in the testicle, but also radiates along the cord towards the loins and back, and down the front of the thigh Severe shock accompanies the pain, and may be so profound as to lead to a fatal issue A well-marked traumatic orchitis often follows, and this may in turn induce atrophy of the organ, although the same condition sometimes occurs without much evidence of inflammation, as a result of thrombosis and occlusion of the spermatic vessels A hæmatocele is also induced by a subcutaneous lesion of this nature Treatment consists in keeping the patient in the recumbent posture with the scrotum well raised, and in applying fomentations or an icebag

**Penetrating Wounds or Punctures** are uncommon except as a result of surgical treatment (*e.g.*, tapping a hydrocele) A certain amount of hæmorrhage usually follows, whilst the immediate lesion is associated with severe testicular pain If the wound becomes septic, the tubules are likely to protrude, and a hernia testis may result All that is ordinarily required is to purify the parts and allow them to heal, sutures should not be inserted into the tunica albuginea, if there is any doubt as to the wound being sterile If the gland is totally disorganized, castration must be undertaken.

**Hæmatocele, or a localized collection of blood in the tunica vaginalis or cord, is a common result of injuries**

1 **Hæmatocele of the Tunica Vaginalis** arises from traumatism, such as a sudden blow or severe strain, and occasionally follows the tapping of a hydrocele if a superficial vessel has been ruptured or punctured, or if the body of the testis has been wounded, it may, however, be due to general oozing from dilated capillaries in the serous membrane owing to the sudden relief of tension It also occurs more or less spontaneously in connection with malignant disease The History generally given is that the patient was seized with a sudden sickening pain in the testicle, which became quickly enlarged without any evidence of inflammation If blood is extravasated at the same time into the scrotum, the integument becomes discoloured in the course of a few days owing to a diffusion of the blood pigment At first the swelling is smooth and fluctuating, exactly resembling a hydrocele, except in the absence of translucency, but owing to a deposit of

fibrin on the walls from the coagulation of the blood, it becomes hard and firm in a short time, closely simulating a solid tumour. In slight cases the blood is entirely absorbed, but when the effusion is considerable the coagulum is likely to persist. On laying open such a swelling, the testicle is usually found in a healthy state, whilst the enlarged tunica is occupied by some blood-stained brownish-yellow fluid, and surrounded by a mass of fibrinous coagulum, part of which is deposited in laminae upon the walls, and part remains as shreddy masses projecting into its lumen. In very chronic cases the walls of the tunica become thick and indurated, and may even undergo calcareous changes. Suppuration is sometimes met with as a result of auto-infection. The **Diagnosis** of a hæmatocele in the earlier stages is easily made, but when it has solidified it can only be suspected by the history, and by the exclusion of other sources of enlargement, whilst an exploratory incision or puncture is often necessary to settle the diagnosis. **Treatment**—When the patient is seen soon after the injury, he must be kept at rest, the parts elevated, and evaporating lotions applied, whilst if the effusion is large, removal of a portion by aseptic tapping will expedite the process of absorption. In more chronic cases it may be necessary to lay the cavity open and remove its contents, whilst in the later stages, if the tunica has become thick and indurated and the testis atrophied, castration may be advisable.

2 **Hæmatocele of the Cord** is but rarely seen. It is due to the rupture of one of its vessels, as a result of injury or strain. A swelling of considerable size rapidly forms, extending along the cord from the inguinal region to the scrotum, but the testis remains free and unimplicated. Such a condition may be mistaken for an **omental hernia**, but on careful examination the tumour is felt to be more uniform in consistency, more rounded in outline, and even semi-fluctuating. It is irreducible and without impulse, whilst the history of the case will assist the surgeon in making a correct diagnosis. **Treatment** in the early stages consists in the application of evaporating lotions, and later on, if the blood-clot is not absorbed, the cavity may be laid open and the coagulum removed.

**Rupture of the Vas Deferens** has resulted from excessive strain, it is, however, very rare, not more than half a dozen cases being on record. It may affect the intra-abdominal portion of the vas, and then gives rise to hæmorrhage from the urethra, together with some amount of fever and hypogastric pain, leading possibly to atrophy of the organ. Rupture of the scrotal portion is followed by enlargement of the testis, and perhaps scrotal hæmorrhage. This was associated in a case under our observation with hæmorrhage from the urethra on attempting coitus shortly after the accident, and subsequently with severe pain and swelling of the testis produced by the same act, but atrophy did not follow. If it occasions any inconvenience, it is best treated by castration.

**Inflammatory Affections of the Testis** may be chiefly confined at their onset either to the body of the organ or to the epididymis, in

the former case the term **Orchitis** is applied to it, in the latter **Epididymitis**, as the case progresses both portions are involved in the process, either condition may be acute or chronic

**Acute Orchitis** most frequently results from injury, but it is also met with as a primary affection in gouty and rheumatic individuals, sometimes arising spontaneously, or it may follow mumps, typhoid, or other eruptive fevers, as a result of metastasis, whilst it is always to some extent associated with epididymitis. In mumps it may precede the parotid lesion, or may even occur without it

The testicle becomes considerably enlarged, exceedingly painful, and tender to the touch. The shape of the organ is more or less globular (Fig 459, A), whilst the pain is of a peculiarly sickening character, extending upwards along the course of the cord towards

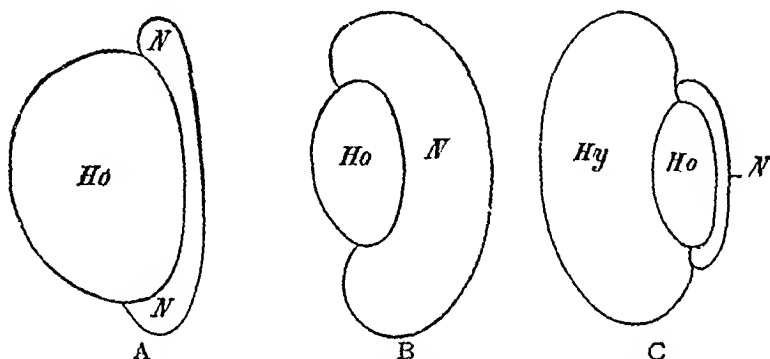


FIG 459—DIAGRAMMATIC SECTIONS OF (A) ORCHITIS, (B) EPIDIDYMITIS, AND (C) HYDROCELE OF TUNICA VAGINALIS (TILLMANN'S)

*Ho*, Testis, *N*, epididymis, *Hy*, hydrocele

the back and loins. The scrotal integuments become red and infiltrated, and, owing to the acuteness of the process, more or less adherent to the coverings of the gland. A plastic or serous effusion into the tunica vaginalis is sometimes present, giving rise to what is known as an 'acute hydrocele'. Some constitutional disturbance accompanies the process, the temperature being elevated two or three degrees, whilst vomiting and constipation are marked symptoms. It is unusual for suppuration to ensue, but an abscess occasionally forms, and then, after the pus has been let out, a hernia testis may follow. Atrophy is a more common sequela, especially in adults, being caused by constriction of the vessels and tubules, owing to organization of the inflammatory exudation.

**Acute Epididymitis** is almost always due to the extension of an inflammatory process from the urethra, the usual cause being gonorrhœa, it occasionally follows the passage of instruments or the lodgment of a calculus, or it may be secondary to a suppurative prostatitis, unconnected with gonorrhœa. It is ushered in by pain in the inguinal region and perhaps in the hypogastrium along the course of the vas deferens, which soon extends to the scrotum

The testicle becomes enlarged, but its shape is that of an elongated oval, somewhat flattened laterally. The epididymis is readily felt as a crescentic swelling, partially overlapping the gland in all directions, and in its concavity the rounded outline of the anterior wall of the testis can usually be distinguished (Fig 459, B), or the tunica vaginalis distended with fluid. The scrotum is red, œdematous, and adherent to the testis, whilst the cord is infiltrated, enlarged, and tender. The same constitutional symptoms are met with as in orchitis. Suppuration is perhaps more common than after the latter affection, since the condition is usually due to a suppurating inflammation of the deeper parts of the urethra, but it is a rare complication. Atrophy of the testis is a not unfrequent result in cases which are not efficiently treated, the plastic material exuded into the epididymis being organized into fibro cicatricial tissue, and constricting the spermatic vessels, an acute attack of double epididymitis may in this way render the individual sterile.

The *Treatment* of both these conditions in the acute stage consists in keeping the patient in bed, with the scrotum supported on a small pillow. The part is assiduously fomented, except when the case is seen very early, an icebag or Leiter's coil being then employed. Leeching should not be utilized, as the triangular leech-bites are very liable to become irritated and septic, and never heal well in the scrotum, if local abstraction of blood appears desirable, one or more of the scrotal veins may be punctured, the hæmorrhage is easily arrested by elevating the part. Pain, if severe, may be mitigated by a hot sitz-bath, or by morphia suppositories. As regards general treatment, the patient, after a preliminary dose of calomel, is kept on a fluid, unstimulating diet, whilst alkaline purgatives are administered, with the addition of tincture of henbane or opium as a sedative, if the pulse is hard and the temperature high, vinum antimonialis in 10-minim doses is also beneficial. When the acute stage is passed, the organ usually remains enlarged, and for a time somewhat tender, it is then best treated by strapping with lead plaster, or with the emplastrum ammoniaci cum hydrargyro. This must be continued until all signs of thickening and induration have disappeared.

**Subacute or chronic** forms of inflammation are also met with affecting the testis or epididymis, either as a consequence of the above, or resulting primarily from blows or strains. The characteristic enlargement is readily detected, associated with a certain amount of tenderness. A useful diagnostic point between the chronic epididymitis following gonorrhœa and that due to syphilis is that the former usually involves the globus minor, and the latter is almost limited to the globus major. The condition is best treated by strapping, and perhaps the administration of small doses of mercury and iodide of potassium may assist in the absorption of the inflammatory products. Chronic orchitis is very similar to the enlargement produced by syphilis, from which, indeed, it can only be distinguished by the absence of a syphilitic history.

**Tuberculous Disease of the Testis** (*Syn* Tuberculous Sarcocoele, Chronic Tuberculous Orchitis) — This affection is most commonly seen in young adults with a distinct tuberculous history, but it also occurs in otherwise healthy individuals. It may commence as a primary affection of the epididymis, or may be secondary to tuberculous disease elsewhere.

**Pathological Anatomy** — The process originates in the connective tissue of the epididymis, and runs its usual course, at first consisting merely of miliary elements deposited around the vessels, which by their coalescence and caseation lead to the formation of cheesy masses, and these at a later stage may emulsify and give rise to abscesses. It may be limited to any one part of the epididymis (most often the globus major), or may widely infiltrate its substance, causing a general enlargement (Fig 460). In the latter case it early tends to spread, either into the body of the testis or along the vas deferens. The corpus Highmorianum becomes first involved by a similar deposit, and finally the intertubular connective tissue of the gland, this is always associated with overgrowth of the epithelium in the tubuli seminiferi, the cells after a time undergoing fatty degeneration, and perhaps to such an extent that, on microscopic section, the normal appearance of the organ has entirely disappeared. An abscess may form within it, and find its way to the surface by burrowing through the tunica albuginea, the visceral and parietal layers of the tunica vaginalis having previously become adherent. After the pus has escaped, a hernia testis is likely to develop. If the process extends upwards along the cord, the vas is mainly implicated, becoming perceptibly thickened, the other structures of the cord being but little affected. The disease spreads along the vas on the outside of the bladder to the vesiculæ seminales and prostate, and may even involve the base of the bladder, the ureters, and kidneys. Lastly, general dissemination of tuberculous disease may occur, and it is a curious fact that meningeal mischief is frequently associated with genital tuberculosis.

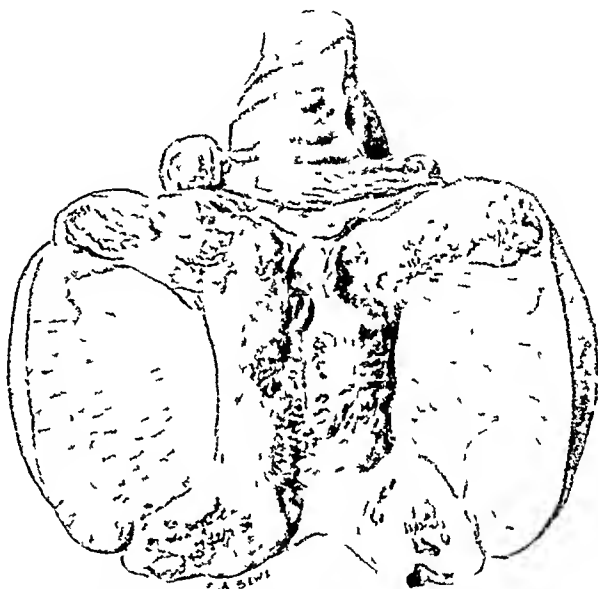


FIG 460 — TUBERCULOUS DISEASE OF TESTIS, MAINLY INVOLVING THE EPIDIDYMIS AND CORD (KING'S COLLEGE HOSPITAL MUSEUM)

**Clinical Signs** —The disease is generally unilateral, although the other testicle often becomes involved at a somewhat later date. Its onset may be abrupt or gradual, in the former case the attack simulates an acute orchitis, but at the end of a week, although the pain subsides, the swelling persists, being followed by the development of abscesses containing cheesy pus. In the more chronic cases, one or more firm and indurated nodules, which are free from tenderness, are felt in the epididymis, but more often the whole of this structure is found to be enlarged and thickened, forming a painless crescentic swelling, surrounding the posterior half of the body of the testis, from which it is usually separated by a deep groove or sulcus. The epididymis is nodular and craggy to the feel, and may be of unequal consistency, areas of softening being interposed between portions which are distinctly hard. The vas is early thickened, and the body of the testis may be involved and enlarged, the line of demarcation between it and the epididymis becoming indistinct. Testicular sensation remains as long as any normal glandular tissue exists, but effusion into the tunica vaginalis is not usual. When suppuration occurs, the pain increases, especially if the abscess is in the substance of the organ. As it finds its way to the surface, the skin becomes adherent to the testis, and is red and congested. Gradually fluctuation manifests itself, and escape of the pus may be followed by a hernia testis. An abscess forming in connection with the epididymis is less painful, and may attain considerable dimensions before it bursts, it never gives rise to a hernia testis. Extension of the disease to the seminal vesicles causes no characteristic symptoms, and is only detected on rectal examination, when, however, the base of the bladder and prostate are affected, considerable dysuria and irritability of the bladder are induced.

The differential diagnosis is discussed at p. 1262.

**Treatment** —Amongst the rich, if seen in the very earliest stage, when only a small nodule exists in the epididymis, it is possible that prolonged residence at the seaside, or a sea-trip, combined with suitable constitutional treatment and local strapping, may lead to its disappearance. If apparently limited to one portion of the epididymis, the disease may be dealt with by the conservative measure of incision, curetting, and applying pure carbolic acid, but such is seldom feasible, since the disease is rarely sufficiently localized.

If the whole epididymis is enlarged and solid, and the body of the testis more or less normal, *epididymectomy* may be undertaken. In this procedure the tuberculous mass is freed from the body of the organ, the spermatic vessels lying on the inner side are carefully guarded, and the vas is dissected out and cleared as high as possible. The presence of an abscess or sinus is no contra-indication, since it merely involves a somewhat freer removal of scrotal integument. Should foci exist in the body of the testis, they are likely to atrophy subsequently, or they can be scraped out at a later date. In this way the function of the gland as the producer of a valuable internal secretion can be retained, although its use as a generative organ is

lost—a retention the more important owing to the likelihood of the other testis being subsequently invaded. If the vas is thickened at the external abdominal ring, it need not deter the surgeon from operating, even if the vesiculæ are enlarged, since tuberculous disease is not like cancer, if the great bulk of the mischief is removed, Nature can frequently eliminate any small portion that remains. In such cases the inguinal canal should be freely opened, and the vas traced backwards and divided. In one case thus dealt with the bladder was distended with boracic lotion, the patient placed in the Tiendelenburg position, and the vas followed back along the side of the bladder nearly as far as the seminal vesicles. For tuberculous disease of the seminal vesicles, see p 1264.

*Casiation* (p 1263) is reserved for cases where the testis is disorganized, and its value as a secreting gland totally destroyed. Of course the cord is then removed also after its division as high up as possible.

**Syphilitic Disease of the Testicle**—The testicle may become affected by syphilis, either in the late secondary or in the tertiary stage, most commonly it results from the acquired variety, but occasionally is met with in the inherited.

**Secondary Syphilitic Epididymitis** is not very frequently seen. It occurs in the form of a chronic enlargement of the epididymis, associated perhaps with a hydrocele, about six to twelve months after infection. The case is very similar to a simple chronic epididymitis, but the nodular thickening mainly involves the globus major, and is usually symmetrical. It readily disappears on the administration of mercury.

**Tertiary Syphilitic Orchitis** is observed at a much later period of the disease, even twenty or thirty years after infection. It is not unfrequently bilateral. **Pathologically**, it resembles the majority of tertiary manifestations in consisting of a diffuse infiltration accompanied by overgrowth of the connective tissue. If the process affects equally the whole organ, the ordinary syphilitic sarcocoele or sclerosis of the testis results, if it is more localized in its distribution, the gummatous variety is said to be present (Fig 461). The former affection is much more common than the latter.

In the tertiary syphilitic sarcocoele, the body of the testis is primarily involved, and becomes evenly enlarged and stony hard. It is globular in outline, frequently accompanied by a hydrocele, and the normal testicular sensation early disappears. The same process occasionally extends to the epididymis and cord. Suppuration is exceedingly rare. On section the characteristic appearance



FIG 461—TERTIARY SYPHILITIC DISEASE OF TESTIS WITH GUMMA OF THE BODY (TREVES SURGERY)



of a testicle has entirely vanished, the tunica albuginea is much thickened, and extending from it through the substance of the organ are bands of connective tissue, representing the normal septa, in bad cases the gland substance is almost completely destroyed.

In the *gummatous* variety a similar condition involves the greater part of the organ, but in addition one or more gummatous foci are present. On section they appear as yellowish-white masses, fairly well defined, and since the central portions are non-vascular, they undergo the usual degenerative changes, becoming soft and diffuent. If the gumma comes to the surface the skin may give way, and a deep syphilitic ulcer with a sloughy base like wet wash-leather results. *Hernia testis* very rarely follows such an occurrence. The clinical features of the ~~gummatous~~ variety are at first similar to those of the former, but after a time one portion of the organ becomes prominent and painful, and as this increases in size the central parts become soft and fluctuating, and finally yield, giving exit to the characteristic gummy contents. Under suitable treatment the swelling in each of these varieties may disappear entirely, leaving the testicle either of normal size or atrophied, but, as in tuberculous disease, its functional utility, if not entirely destroyed, is probably impaired considerably.

For the differential diagnosis, see p 1262

**Treatment** consists in the administration of iodide of potassium and mercury, whilst the hydrocele may be tapped, and the organ strapped or supported by a suspender. If a gummatous ulcer is produced, it may be possible to excise the greater portion of the characteristic slough at its base, but in all cases it should be dressed with lint or gauze steeped in *lotio nigra*, or some other mercurial preparation.

**Hernia Testis** is the term applied to a protrusion of the substance of the gland, more or less infiltrated with granulation tissue, through an opening in the tunica albuginea and skin of the scrotum. It arises from various causes, such as a septic penetrating wound of the testis, acute suppurative orchitis, or from a chronic abscess, whether simple or tuberculous in nature. It is rarely produced by the breaking down of a gumma, owing to the extensive infiltration of the organ with fibro-cicatricial tissue, and necessarily it never follows suppuration in the epididymis. It is always preceded by a condition of increased pressure within the tunica albuginea, and consequently as soon as an aperture is formed in this membrane, its natural elasticity, allowing of its contraction, forces a portion of its contents out of the opening, this may even proceed to such an extent as to cause the whole of the substance of the gland to protrude, the tunica albuginea being practically turned inside out. A mass resembling granulation tissue is then seen to project through an opening in the scrotum, it is often somewhat pedunculated or mushroom-like in shape, possibly overhanging the margins of the skin, but in less advanced cases the integument may be distinctly undermined. A considerable discharge of pus usually accompanies it. The condition

must be distinguished from the fungating growth which occasionally results from malignant disease of the organ, when the protrusion consists of tumour substance, with no trace of testicular tissue

The **Treatment** of hernia testis usually consists in extirpation of the organ, especially when it is affected by tuberculous disease. In simple cases it may be possible to obtain healing of the wound by keeping the part aseptic, and applying pressure by means of a pad of gauze. In other cases it may be possible to separate the mass, and after paring the edges of the wound, to bring them together by sutures, and thus cover in the gland substance, which, however, remains projecting from the opening in the tunica albuginea. Such proceedings are seldom very satisfactory.

**Tumours of the Testis** are generally malignant in character, only one non-malignant form being at all common, viz, fibro cystic disease, or adenoma testis.

**Fibro-Cystic Disease** (*Syn* Adenoma Testis, Cystic Sarcocoele) — This condition is characterized by the formation of a tumour of variable size, scattered through the sub-

stance of which are numerous cystic cavities, lined with cuboidal or stratified epithelium. These cysts are usually rounded, but occasionally tubular in shape, and may communicate with one another, they contain serous fluid and sometimes intracystic growths. They are surrounded by connective tissue, the amount and character of which vary greatly in different cases. It consists mainly of simple fibrous tissue, but it is very common to see cartilaginous nodules (Fig 462, 2) and myxomatous foci scattered through its substance, and is very prone after a time to undergo a malignant transformation. According to Bland Sutton and Eve, these tumours arise from the remains of the Wolffian body or mesonephros, which is almost always normally represented in the neighbourhood of the globus major of the epididymis by the structure known as the organ of Giraldés (paradidymis). The testicle can be found in most cases spread out in a thin layer over the tumour substance (Fig 462, 1)

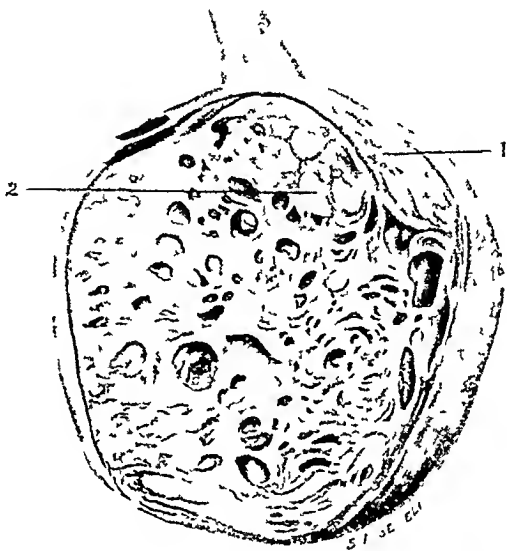


FIG 462 — FIBRO CYSTIC DISEASE OF THE TESTIS (COLLEGE OF SURGEONS MUSEUM)

- 1 Body of testis spread out over the growth
- 2 nodules of cartilage contained in the growth

**Clinical Signs**—This condition is met with in young adults, and may possibly be attributed to an injury. The organ steadily becomes enlarged, but this gives rise to no inconvenience except by its size and weight. It is round in outline and elastic in consistency, the cord remaining unaffected unless malignant disease supervenes. When of great size, the skin of the scrotum may ulcerate. The case runs a chronic course, and even should the growth become malignant, the change of type only appears late in the disease.

**Treatment** consists in removal after an exploratory incision has demonstrated the nature of the growth.

Other non malignant tumours have been described, such as chondroma, osteoma, fibroma, myxoma, etc., but they are exceedingly uncommon, if they occur at all apart from sarcoma or fibro-cystic disease.

**Sarcoma of the Testis** commences in the body of the organ, either within the first decade of life or between the ages of thirty and forty, and is sometimes a sequela of late or imperfect descent. It is usually a soft, round-celled growth, taking on the form of a lympho-sarcoma, in other cases it is harder, and of the nature of a fibro-sarcoma. Frequently cartilaginous nodules are incorporated in its substance, and patches of myxomatous tissue or cystic degeneration from hæmorrhage are also seen. As already stated, it is sometimes secondary to fibro-cystic disease. It originates in the connective-tissue elements of the organ, the glandular substance being early destroyed. It appears as a rounded swelling, and at first its outline is irregularly smooth, as the disease progresses, however, it may become nodulated from the development of cysts. The tumour may attain very large dimensions, but the cord and scrotal tissues only become affected in the later stages, and then ulceration and the formation of a fungus testis occasionally follow. Secondary growths are always found in the lumbar glands and internal organs, whilst, when it has spread beyond the tunica albuginea, involving the scrotal structures, the inguinal glands may be similarly affected. There are but few subjective symptoms at first, a feeling of weight and dragging being alone experienced, whilst testicular sensation is soon lost, but at a later date, when the cord is involved, pain and cachexia become very marked. The Course of these cases is slow up to a certain point, but the tumour may then rapidly increase in size, spreading along the cord to the interior of the abdomen even in the course of a few weeks, thereby rendering removal utterly impossible, although it would have been easily practicable at an earlier period. **Treatment** consists in the extirpation of the growth with the testis as early as possible, the cord being divided high up.

**Carcinoma of the Testis** is usually of the encephaloid type, and arises in the body of the organ as a soft rapidly-growing tumour, which soon extends to the tissues of the cord, and contracts adhesions to the scrotum, ulceration and the formation of a fungating mass follow, whilst secondary deposits are found in the lumbar and inguinal glands, and sometimes in the viscera. It is impossible to

distinguish a carcinoma from a sarcoma of the testis by clinical signs, since it usually occurs at the same period of adult life, and very rarely in children. Very rapid growth, and early enlargement of the cord and lymphatic glands, point, however, to cancer rather than sarcoma. The only treatment is castration.

**Hydrocele**—Any collection of fluid, other than pus or blood, in the neighbourhood of the testis or cord is termed a hydrocele. The fluid usually consists of serum, but in some forms spermatozoa are also present, and in rare cases it may consist of chyle or a similar milky fluid (chylous hydrocele). Two chief varieties are described, according to whether the testis or the cord is involved.

I In **Hydrocele of the Testis** the fluid is contained in the tunica vaginalis (vaginal hydrocele) or exists as a circumscribed swelling in its neighbourhood (encysted hydrocele).

1 A **Vaginal Hydrocele** is one in which there is an accumulation of fluid in the tunica vaginalis, and the following varieties may be differentiated.

(a) *Acute Hydrocele* occurs in conjunction with acute inflammation of the testis or epididymis. The effusion of fluid is never abundant, and is often only made out on careful examination, at first it consists of plasma, as in all acute inflammations of a serous membrane, and is therefore spontaneously coagulable. It may become chronic, or may disappear entirely, perhaps leaving a few adhesions.

(b) A *Congenital Hydrocele* occurs in cases in which the funicular process is still patent. The general signs of a vaginal hydrocele, as described below, are present, but the fluid can be returned by pressure into the abdominal cavity. It is rarely seen in others than infants, and may be treated by the application of evaporating lotion to the scrotum, whilst a light truss or woollen support is placed over the inguinal canal, as for congenital hernia. It is often associated with phimosis, which should, of course, be dealt with by circumcision. If it persists, it may be treated by operation as for congenital hernia, to which, indeed, it frequently leads.

(c) An *Infantile Hydrocele* is due to non-obliteration of the funicular process of peritoneum, except at its upper extremity. It presents the signs of an ordinary acquired hydrocele, the fluid, however, extending along the cord, even into the inguinal canal. Its treatment is the same as for an acquired hydrocele.

(d) A *Bulocular Hydrocele* is one in which there is an additional locus within the abdominal cavity communicating by a neck of variable size with the distended tunica vaginalis. It is due to a persistence of the intra-abdominal portion of the funicular process between the peritoneum and internal abdominal ring, this becomes distended with fluid, and the collection burrows downwards in front and by the side of the bladder towards the pelvis. We have operated on a similar condition in a woman, originating in the upper portion of the canal of Nuck.

(e) Acquired Vaginal Hydrocele is the most common variety.

**Causes**—It may arise in middle-aged persons without any apparent cause, but is usually associated with chronic orchitis. A hydrocele almost always accompanies a tertiary syphilitic enlargement of the organ, but is uncommon in tuberculous or malignant disease. Hydrocele is very frequently seen in those who dwell in hot climates, probably as the result of a lax and pendulous condition of the scrotum and testicles. In India natives always support the scrotum.

**Signs**—Vaginal hydrocele appears as a rounded pyriform swelling in the scrotum, which extends for a variable distance along the cord.

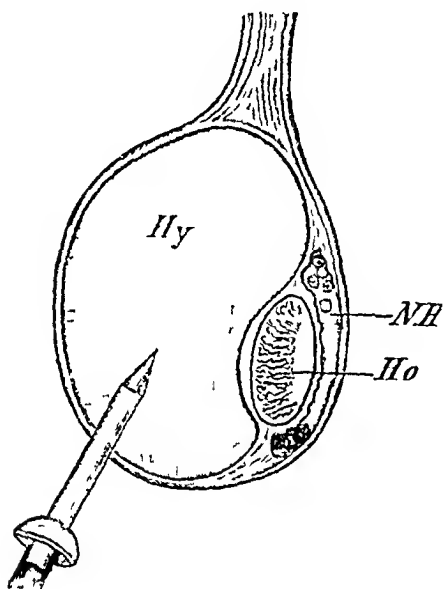


FIG 463 —METHOD OF TAPPING A HYDROCELE (TILLMANN'S)

Ho, Testis, NH, epididymis,  
Hy, hydrocele

Its tension differs with the amount of fluid present, and with the thickness of its walls, it is generally elastic, and with obvious fluctuation. The cord is felt distinctly above the rounded upper part of the tumour, and the testis is generally situated posteriorly (Fig 459, C), although it projects forwards into the cavity, and is thus not readily detected. Its position may be ascertained by pressure over it, when the characteristic testicular sensation is evolved. On holding a light close to the scrotum, the tumour is seen to be translucent, and the position of the testicle can be demonstrated. In old-standing cases the walls become exceedingly thick, and even cartilaginous or osseous plates have been observed in them, the translucency in such

cases will be lost. Occasionally, when inflammation has existed, adhesions may form between the testis and the anterior wall, and irregularity in the shape of the tumour is thereby induced, or the cavity may be divided into compartments by fibrous bands or septa.

It is scarcely necessary to mention that there is no impulse on coughing, and that the tumour is dull on percussion. When the distension is very great, its weight causes a dragging pain, the penis becomes buried in the swelling, and eczema of the scrotum may result from the urine trickling over it. The fluid in the sac is yellowish or straw-coloured, its specific gravity varies from 1015 to 1025, it contains a large amount of albumen, especially fibrinogen. In old-standing cases cholesterol may also be present.

The Treatment of vaginal hydrocele is palliative or radical. Palliative treatment consists in tapping the cavity and removing the fluid, the patient being subsequently directed to wear a suspender,

and, where inflammation of the testis exists, to apply cooling lotions. For chronic orchitis strapping of the testis may be required. In order to tap a hydrocele, the tumour must be firmly grasped in the palm of the left hand, and the skin over its anterior wall purified and made tense. A spot at the antero inferior margin is then selected, as free from vessels as possible, and a fine sterilized trocar and cannula inserted almost directly upwards, so as to pass in front of the body of the testis. The site selected for tapping must, of course, vary with the position of the testicle, which should be previously demonstrated. The fluid having been withdrawn, the cannula is removed, and the puncture covered with wool and collodion. The condition usually recurs after a longer or shorter period, and the operation may then be repeated. If a dirty instrument is employed, inflammation, and even suppuration, may follow, whilst if a vessel or the body of the testis is punctured, a hæmatocele may result.

Many different plans have been suggested for the Radical treatment of hydrocele. It is unnecessary, however, to do more than describe the two most frequently adopted. (1) *Injection* of the cavity after tapping has long been a favourite method. Many different reagents have been employed, such as port wine, tincture of iodine, solution of corrosive sublimate (1 in 500), or glycerine of carbolic acid. Perhaps the best is the tincture of iodine, but that contained in the British Pharmacopœia is not strong enough, and the old Edinburgh tincture, which is nearly the same strength as the  $\text{lin } \text{iodi, B P}$ , should be employed. The amount used varies with the size of the hydrocele, but for one of moderate dimensions it will suffice to inject, after tapping, 2 drachms of the tincture, and after manipulating it well within the cavity, a part, say 1 drachm, is allowed to escape. Smart inflammatory reaction follows, and a cure may result, probably from obliteration of the vaginal space by the formation of adhesions. In a certain percentage of cases failure may be expected, and this is more likely to happen if too weak an irritant has been employed, or if the hydrocele is a chronic one with thick and indurated walls, or has been tapped on several previous occasions. (2) The *open method* of operation is now generally adopted, and is particularly recommended in large and chronic cases. The hydrocele is cut down on through an incision in the upper part of the scrotum, and the tunica vaginalis isolated from the superjacent structures. The cavity is opened, and the parietal portion of the tunica snipped away with scissors close to the testicle. A number of vessels will need to be ligatured, a drainage-tube is inserted, and the wound closed in the ordinary way. The results of this practice are most satisfactory.

When the sac is not too large, and the tunica supple and uninfilted, it often suffices to turn it inside out after opening it, and stitching its edges to the back of the testis or epididymis. We have operated in this way on many cases and with excellent results.

In infants hydrocele is by no means uncommon, and may be, but is not always, of the congenital type. The communication is sometimes very small, so that reduction is impracticable, although on

lying up the cavity slowly empties, it is desirable to make certain as to this point before undertaking treatment. If the sac communicates with the peritoneal cavity, it may be treated as a hernia by truss pressure, or more satisfactorily by operation. If no communication exists, many cases get well spontaneously, but as a useful *placebo* the scrotum may be painted over frequently with a lotion of chloride of ammonium (grs.  $\times$  ad  $\mathfrak{z}$ i mixed with rectified spirit and water), failing this, acupuncture may be tried, the fluid being allowed to trickle into the scrotal tissues. In the few cases in which this fails, an open operation (incision with drainage or partial removal of the sac) will be required.

2 **Encysted Hydrocele of the testis** occurs in two main forms, according to whether it arises in connection with the epididymis or the body of the testis.

(a) *Encysted Hydrocele of the Epididymis* exists usually as a rounded globular swelling, tense and elastic in consistency, and translucent. It is situated above the body of the testis, and close to the head of the epididymis (Fig 464). As a rule, it does not attain a size greater than that of the body of the testis itself, so that it may appear as if a double testicle was present, the hydrocele is, of course, devoid of testicular sensation. Less frequently it may attain considerable dimensions, even projecting below and around the testicle, which, though enveloped by it, is quite distinct from it.

The fluid contained within these

cysts is usually milky and opalescent in appearance, owing to an admixture of semen, under the microscope spermatozoa, either living or dead, can be demonstrated, on account of this it is sometimes termed a *spermatocele*. The specific gravity is lower than that of ordinary hydrocele fluid, and there is but little albumen. The origin of these cysts has given rise to much discussion. They are of a very different nature to the ordinary vaginal hydrocele, or even to the encysted hydrocele of the cord, since the walls are not lined with endothelium, but with cuboidal or columnar epithelium. They are probably due either to a dilatation of one or more of the vasa efferentia testis, or more frequently to distension of some of the foetal relics always found near the head of the epididymis, especially of those known as Kobelt's tubes, these, as also the vasa efferentia testis, are derived from the tubules of the Wolffian body, differing,



FIG 464 —ENCYSTED HYDROCELE OF EPIDIDYMIS (COLLEGE OF SURGEONS' MUSEUM)

however, from them in not becoming attached to the body of the testis (Fig 58, p 217) They are thus homologous with the parovarian cysts found in the female Smaller pedunculated cysts containing clear serum are sometimes met with in this region, arising from a distension of the hydatid of Morgagni, which is developed from the remains of the Mullerian duct

**Treatment** is conducted along the same lines as for vaginal hydrocele, viz, by tapping as a palliative measure, and injection or excision, in order to establish a radical cure.

(b) *Encysted Hydrocele of the Tunica Albuginea* is a condition rarely seen, consisting of a small collection of serous fluid beneath the visceral portion of the tunica vaginalis It is probably due to dilatation of lymphatic spaces, and has absolutely no clinical significance

II **Hydrocele of the Cord** occurs, as already described, in connection with the congenital and infantile varieties of vaginal hydrocele If limited to the cord, it exists in one of two forms, the encysted or the diffuse

✓ 1 **Encysted Hydrocele of the Cord** arises from imperfect obliteration of the funicular process of peritoneum, the patent portion becoming distended with fluid and giving rise to a cavity lined with endothelium It is usually detected as a rounded elastic swelling, occupying the inguinal canal, moving freely up and down within it The upper border is sharply limited, and in favourable cases translucency can be demonstrated On fixing the testicle the cyst is no longer moveable The fluid contained within it is identical in nature with that in a vaginal hydrocele In the female a similar condition arises from imperfect obliteration of the canal of Nuck, giving rise to what is known as a *hydrocele of the round ligament* **Treatment** consists in removal of the fluid by tapping, or, if a more radical proceeding is necessary, by injection or excision

2 **Diffuse Hydrocele of the Cord** is but rarely seen It results from a diffuse œdema of its cellular tissue, and presents on examination a fusiform or sausage-shaped tumour, which extends along the cord for a variable distance

The term **Chylous Hydrocele** is applied to a distension of the tunica vaginalis with a chylous fluid, recognised by being milky in appearance, and under the microscope seen to consist of a fatty emulsion Several modes of origin have been suggested, but none are very satisfactory In one case under our care, a series of dilated lymphatics filled with a similar fluid extended upwards from the testicle to the inguinal canal

**Varicocele** —A varicose condition of the pampiniform plexus is very commonly met with in young men, but seldom in those of advanced age, except when it has become chronic, or is due to malignant disease of the kidney (p 1174) It usually occurs in individuals with a lax and pendulous scrotum, and is often associated with masturbation, which induces abnormal vascularity of the testis The fact that it sometimes develops in quite young boys suggests,



however, that there is some congenital condition associated with it. It may also be caused by the pressure of a truss applied for the relief of a hernia. It is almost invariably on the left side, and the reasons given for this are as follows: (a) The left testis usually hangs lower than the right, and hence the spermatic veins are longer and exposed to greater blood pressure. (b) The left spermatic vein opens into

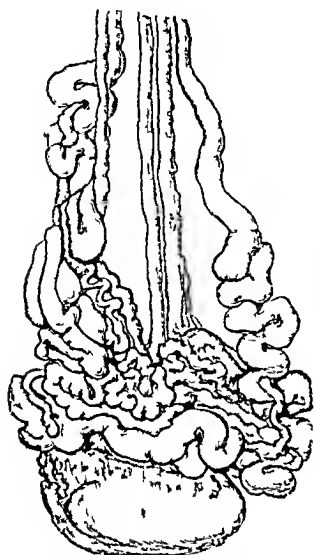


FIG 465 - VARICOCELE  
(TREVES' 'SURGERY')

the left renal vein at right angles, and no valve is present at the orifice, whilst that on the right side opens obliquely into the vena cava and is valved. (c) The presence of the sigmoid flexure on the left side of the body, and its distension by accumulated faeces as a result of constipation, may lead to pressure on the abdominal portion of the left spermatic vein.

A varicocele is characterized by the presence of a soft irregular swelling in the scrotum, which is somewhat pyramidal in shape, the main mass being below and slightly overlapping the testis, and the apex above. It consists of dilated and tortuous veins, the outlines of which can often be seen through the skin (Fig 466). They impart a sensation to the finger which has been likened to a collection of worms in a bag; there is a distinct impulse down the veins on coughing. On assuming the recumbent posture the swelling almost

disappears, owing to the vessels being emptied of their contained blood, if pressure is subsequently applied over the external abdominal ring, and the patient allowed to stand, the tumour reappears, filling from below upwards. A sensation of weight and pain usually accompanies a varicocele, whilst severe neuralgia of the testis may be induced. It is a frequent source of seminal emissions, and may result in testicular atrophy. Phlebitis is liable to follow an injury, and may lead to a spontaneous cure, if one of the dilated veins is ruptured, severe hæmorrhage ensues, causing a diffuse hæmatocele of the cord. In favourable cases the condition disappears spontaneously.

The **Diagnosis** of varicocele is easily made, the only condition for which it is likely to be mistaken being an omental hernia, the difference between the two conditions has been discussed at p 1072.

The **Treatment** of slight cases of varicocele consists in supporting the testicle and scrotum by means of a well fitting suspender, whilst the patient is also instructed to bathe the parts with cold water night and morning, and to take such measures as shall ensure a daily action of the bowels.

**Radical Treatment** by excision of the veins is advisable in neuralgic cases, where atrophy of the testis is threatening, or in order to fit the patient for admission into any of the public services.

The operation is conducted as follows. The pubic region having been shaved and purified, an incision  $1\frac{1}{2}$  inches long is made in the direction of the cord, with its centre a little below the external abdominal ring. The structures of the cord are raised on the fingers, and the coverings divided, so as to expose the spermatic veins at their upper end. Two main branches are usually found in this situation, but occasionally there is only one. These are cleaned and carefully isolated from the other structures of the cord, and a ligature is applied to them at the external abdominal ring. The vessels are now clamped with a pair of Spencer Wells forceps below the ligature, and divided between it and the forceps. The



FIG 466 —LARGE VARICOCELE IN A PATIENT AGED 35 YEARS, WHO HAD USED NO SUPPORT FOR MANY YEARS

lower end, grasped by the forceps, is stripped downwards, so as to free the pampiniform plexus from the other elements of the cord, and the dissection can be carried nearly as far as the epididymis by drawing the testicle up into the wound. The lower end of the veins is ligatured in one or two portions, and divided. By this means the whole varicocele is removed. If the scrotum is pendulous, and the testicle hangs low, it may be advisable to raise it by tying the upper and lower ligatures together, care being taken not to pull them off in so doing, perhaps it is wiser to introduce a suture through the divided ends of the veins above and below, which are purposely left long. The wound is then closed without a drainage tube, and dressed as usual. The patient is kept in the recumbent posture for a fortnight, until organization has occurred in the divided ends of the veins, and a firm cicatrix has formed. This method of treatment is infinitely superior to that often practised of exposing the veins in the scrotum, since a wound in the groin always heals much more readily than one in the scrotum, whilst it is easier to dissect the veins out

from above, where only one or two trunks exist. The venous return after the operation is maintained by the vein or veins running with the artery to the vas in the posterior portion of the cord. Occasionally, if the removal of veins has been too complete, a hydrocele develops subsequently, owing to the passive congestion of the testis. It is usually unnecessary to remove any scrotal integument, although it is often redundant, but after the wound is soundly healed, the dartos may be stimulated daily by brushing the scrotum with a clothes brush.

**Neuralgia of the Testis** is characterized by the organ becoming exquisitely tender and painful, although apparently healthy. It usually occurs in young adults of nervous-temperament, or in middle-aged gouty men. It is not uncommonly associated with a varicocele. The pain is usually paroxysmal in character, and very intractable. **Treatment** must be directed mainly to the general health, consisting in the administration of nerve tonics, such as iron and quinine, whilst locally sedatives, *e.g.*, belladonna and aconite, may be applied. It is also advisable that a suspender should be worn.

**Atrophy of the Testis** results from several causes. (i) It may be due to a congenital arrest of development, as met with in displacement or late descent. (ii) It is most frequently the consequence of inflammatory affections, either of the body or epididymis, owing to the cicatricial contraction caused thereby leading to compression of the vessels. It occasionally follows the metastatic orchitis of mumps, especially in adults, whilst it is also due to syphilitic disease. (iii) It arises from impaired nutrition, as after the division of the spermatic arteries in operations for varicocele or hernia, or from compression of the cord by closing the inguinal canal too firmly in the operation for the radical cure of hernia. (iv) Chronic congestion of the organ, as by a varicocele, may induce atrophy, whilst (v) sexual excesses are also stated to lead to it. If unilateral, it is of comparatively little importance, but where both organs are affected, sterility is sure to result, and the patient, if previously young and healthy, is likely to become depressed in spirits and melancholic. This may be due in part to mental causes, but also in measure to the absence of seminal secretion, the reabsorption of which into the system is, according to Brown-Séquard, an important factor in the maintenance of a vigorous state of mind and body.

### General Diagnosis of Scrotal Tumours

When a patient presents himself for examination with a swelling in the scrotum, the surgeon has to decide whether it is a hernia, a hydrocele, a hæmatocele, a varicocele, or a solid enlargement of the testis, and, if the latter, of what nature. The first point to which attention is directed is the condition of the cord immediately below the external ring. If this is of normal size and consistency, hernia and diffuse hydrocele of the cord are thereby excluded, whilst the existence of a rounded tense swelling, moveable within the canal, but becoming fixed on holding the testis, indicates that an encysted

hydrocele of the cord is probably present. When, however, the cord is more or less masked, further examination speedily determines whether a hernia or a diffuse hydrocele or hæmatocele of the cord exists, since the former is often reducible, has an impulse on coughing, and is rounded or nodular in outline, and the latter are sausage-shaped, always irreducible, and semi-fluctuating.

When the swelling is purely scrotal, inspection and manipulation will at once decide if it is a varicocele, by its characteristic feel, by its disappearance on assuming the recumbent posture, and filling again from below on standing up. If the swelling is rounded in outline, the next point to be determined is whether it is solid or fluid. If fluid, it is probably a hydrocele, or the early stage of a hæmatocele, the translucency of the former, and the sudden appearance and non-translucency of the latter, should suffice to demonstrate its nature. It is possible that the hydrocele is merely a secondary complication, and hence no final opinion should be given until it has been tapped, and the condition of the body of the testis investigated. If, however, a solid mass exists in the scrotum, it is either a hæmatocele in its later stages, or some form of sarcocele, whether simple, syphilitic, tuberculous, or neoplastic. A hæmatocele is possibly recognised by its history, and by there being a fluid centre to the swelling, surrounded by solidified tissue. *Chronic orchitis* and *syphilitic* enlargement of the testis are so much alike as to render diagnosis always uncertain in the absence of a distinct syphilitic history, but if the swelling is extremely hard, with a smooth and regular outline, without testicular sensation, limited to the body of the testis, and accompanied by a hydrocele, it is probably syphilitic. *Tuberculous* disease, on the other hand, occurs more frequently in younger individuals than does the syphilitic variety, whilst the epididymis is usually first attacked, becoming nodulated, the cord is early implicated, hydrocele is rare, suppuration is frequent, and testicular sensation remains till the body of the testis is disorganized. *Tumours* always impart a distinct sense of weight to the hand, quite different to that noticed in tuberculous or syphilitic disease, if a simple tumour is present, it is rounded, slow in growth, and the cord is unaffected. Malignant disease is characterized by rapid growth, more severe pain, and early implication of the structures of the cord and of the lumbar lymphatic glands. The enlargement of both testes is in favour of tubercle or syphilis rather than of malignant disease. A certain small number of cases will remain where, in spite of every care, the nature of the mass is still a matter of doubt, in such the diagnosis cannot be established without puncture or an exploratory incision.

Whilst weighing carefully the local conditions, we must not omit thoroughly to investigate and appreciate the general history and condition of the patient, his age, appearance, previous habits and illnesses, etc. At the same time, an examination of the internal organs should be made to ascertain, as far as possible, the existence or not of concurrent disease, e.g., tuberculous disease of the lungs or kidneys, or secondary malignant deposits.

Castration is required for many different conditions, which have

been already described, *e g*, for malposition, tuberculous disease, old-standing hæmatoceles, and simple or malignant tumours. The operation is conducted as follows. The pubes and perineum having been previously shaved and purified, the surgeon, standing on the same side of the patient as the organ to be removed, makes an incision down to the testis. If large and adherent to the scrotal tissues, the incision must necessarily involve the scrotum, but wherever practicable it is wise to avoid the scrotal integuments, making the incision over the cord. It should always extend upwards as far as the external abdominal ring, so as to enable the structures of the cord to be divided high up, a most important matter in tuberculous and malignant disease, the inguinal canal can then also be closed, if necessary. The testis or tumour is enucleated from its surroundings, and the cord isolated and divided as high as possible, after transfixing and securely ligaturing it with silk. Some surgeons prefer to separate the tissues of the cord, and to take them up individually, but this is a matter of little importance. The stump should not be allowed to slip back into the canal until all bleeding has completely stopped, and it has been suggested that the cut end of the vas should be touched with pure carbolic acid as a precautionary measure. All bleeding points in the scrotum are now secured by ligature, and these may be numerous, the wound is closed by sutures, a drainage-tube being inserted in the scrotum, and by choice coming to the surface at the upper end of the wound, that is, as far from the perineum as possible.

In the performance of double castration, it is recommended to make two crescentic flaps from side to side, so as to include between them a portion of the scrotal integument, in order to reduce the subsequent redundancy of unnecessary tissue.

### Affections of the Vesiculæ Seminales

**Acute Vesiculitis** is not often met with, but sometimes arises in association with prostatitis, as a complication of gonorrhœa. It is characterized by deep-seated pain in the perineum, together with irritability of the neck of the bladder and increasing frequency of micturition. Defæcation becomes painful, and on examination of the rectum the vesiculæ can be felt enlarged and tender. If suppuration ensues, an abscess forms, which usually bursts into the rectum, but sometimes into the bladder or peritoneal cavity. As a rule, the condition disappears *pau passu* with the gonorrhœa, but when suppuration has supervened, it is advisable to open the abscess by a deep incision through the perineum, guided by a finger in the rectum.

**Subacute or Chronic Vesiculitis** is not uncommon, the latter condition being often associated with prostatitis and one of the most frequent causes of gleet. Seminal emissions and priapism may be caused by it and the enlarged organ can be felt through the rectum. A good deal of pain, often referred to the back is experienced. The treatment is the same as for chronic prostatitis.

**Tuberculous Disease** attacks the vesiculæ seminales as a result of extension from the testis along the vas, being almost always associated with similar disease of the prostate and base of the bladder. The organs can be felt enlarged, and if suppuration occurs the abscess may burst into the rectum or bladder, or possibly into both, a recto-vesical fistula being thereby developed. It is possible to reach the vesiculæ through a semilunar incision in the perineum displacing the rectum backwards and the bladder and prostate forwards or from behind by removing the coccyx and part of the sacrum as in Kraske's operation. When exposed,

complete excision is sometimes possible, or an opening is made into them, and the cheesy contents scooped out

## Affections of the Scrotum

**Injuries of the Scrotum** —Contusions and blows give rise to ecchymosis, which may be so extensive as to warrant the term *hematoma scroti* which has been applied to it

Incised wounds may affect the skin and subcutaneous tissues, or may lay open the tunica vaginalis, with or without protrusion of the testicle All that is needed in such cases is to render the wound aseptic, and to deal with it on general principles Considerable destruction of scrotal tissue may be repaired by trans plantation of flaps from the inguinal region, or by grafting according to Thiersch's method

**Cellulitis of the Scrotum** most commonly results from extravasation of urine, for which see p 1236 It may occasionally arise from other causes, and leads to great constitutional disturbance, usually of an asthenic type, and often to considerable sloughing, the testes may be exposed when the sloughs come away, or may even be involved in the same process As a general rule repair is very active in the scrotum

**Edema of the Scrotum** is usually due to dropsy, being often associated with general anasarca and ascites It may attain considerable dimensions *Acute inflammatory edema* of the scrotum is a term sometimes applied to erysipelas affecting this region, on account of the absence of the vivid red colour usually caused by that affection Considerable edema is always present, and gangrene of the skin may result As soon as the gangrene becomes limited, it should be excised and the margins of the wound brought together by sutures or allowed to heal by granulation

**Scrotal Fistulæ** are usually due to the bursting of abscesses in connection with the urethra (see Perineal Abscess)

**Sinuses of the Scrotum** are often found in connection with tuberculous or syphilitic disease of the testicle

**Eczema of the Scrotum** is a troublesome affection, giving rise to great pruritus and irritation It results from the presence of pediculi but the more chronic forms occur amongst workers in tar and paraffin, and also in chimney sweeps, being due to the constant irritation of the corrugated scrotal integument by dirty clothes It is characterized by the presence of warty outgrowths and not unfrequently runs on to **epithelioma**, originating the condition known as *chimney-sweep's* or *paraffin cancer* (Fig 467) The usual characteristics of such a new growth are present, and in some of the deeper cells particles of soot have been demonstrated The inguinal glands are usually involved but not till late and the progress of the case is slow The only treatment which can be adopted is complete removal the wound caused thereby being closed or allowed to granulate

For **Elephantiasis Scroti**, see p 361



FIG 467 — EPITHELIOMA SCROTII FOLLOWING PARAFFIN ECZEMA (TILLMANN'S)

## CHAPTER XLII

### SURGERY OF THE FEMALE GENITAL ORGANS

**Affections of the Vulva**—Injuries to the External Genitalia may arise from direct violence, or during parturition from the forcible expulsion of the head. In the non-pregnant condition the results differ but little from other similar lesions, and require no special treatment or consideration. Occasionally a kick or a fall on a stick or paling may result in *laceration of the recto-vaginal septum*. The wound is usually contused, and the margins irregular, so that immediate suture is unlikely to succeed. The parts are therefore kept clean by frequent douches and allowed to granulate, and the loss of substance is in that way often made good, should a fistula persist, a plastic operation will be subsequently necessary. Of course, if the original injury is a clean incision, immediate operation to close the defect is desirable.

In the pregnant state or when large varicose veins are present, an injury to the vulva may result in serious hæmorrhage if there is an external wound, or in the formation of a large *hæmatoma*. The labium becomes much swollen and firm to the touch, owing to the coagulation of the blood, suppuration often follows, especially if the injury is associated with a superficial abrasion. **Treatment**—If the hæmatoma should hinder parturition, it may be necessary to incise it at once and turn out the blood-clot. Under other circumstances it may be treated by the application of cooling lotions, but should it persist or if suppuration ensues, operation will be required, the cavity is opened, emptied and stuffed with gauze to ensure healing by granulation.

**Varix** of the vulva is not unfrequently associated with a similar condition in the legs, or may sometimes arise as a result of blocking of the external iliac vein, owing to the opening up of collateral branches. One or two veins may become enlarged, often running transversely across the Mons Veneris, or large bunches of veins may

\* It is impossible in a work of this size to include more than a comparatively brief notice of the more important gynæcological conditions which encroach on the domain of the general surgeon. As a means of distinction we have considered that all vaginal operations, etc., are purely gynæcological whilst those necessitating abdominal section belong as much to the general surgeon as to the gynæcologist. Vulval lesions of course may come under the care of either

form in the labia. Pregnancy usually aggravates this condition to an alarming degree, and a very slight injury may determine a rupture of the veins. **Treatment**—If troublesome and causing much pruritus or irritation, the veins may be excised under careful antiseptic precautions.

**Vulvitis**, or inflammation of the lining membrane of the vestibule, is due to uncleanness, gonorrhœa, or to irritating discharges coming from above. It is characterized by injection of the mucous membrane, by itching or smarting pain, especially on walking, and a secretion of mucus or muco-pus, causing the labia to stick together. The mucous follicles may become affected, and a localized abscess result, situated either immediately beneath the mucous membrane or in the substance of the labium. The *treatment* consists in the use of warm and mild astringent or antiseptic lotions to purify the part (*e g*, lotio plumbi), sitting in hot water being most beneficial. At the same time the patient is kept quiet, and the bowels are opened by a saline purge. When a follicular abscess forms, it should be incised through the mucous membrane and its cavity stuffed with a small portion of dressing. A labial abscess should be freely opened at any spot where it is tending to point, and the cavity packed with gauze to ensure healing from the bottom.

**Vaginitis** may be secondary to vulvitis, or associated with an inflammatory affection of the uterus. As a primary lesion it is most commonly due to injury, such as the injection of too hot water, or the presence of a foreign body, *e g*, a badly-fitting and retained pessary, or awkward or violent coitus. Vaginitis is not generally a marked feature in gonorrhœa. The symptoms are a sense of heat and pain, frequent and painful micturition, and a free muco-purulent leucorrhœa. Complications may arise from extension upwards to the uterus and tubes. **Treatment** consists in warm soothing injections in acute cases, together with hot hip-baths, in the more chronic types astringent injections are required.

**Cysts of the Labia** are occasionally seen, being due to the blocking of the duct of a mucous follicle, or of the more specialized vulvo-vaginal glands (glands of Bartholin), they may attain considerable dimensions, and must be freely dissected out if causing any inconvenience.

Various other tumours of the vulva occur, *e g*, elephantiasis, epithelioma, etc., but have no special peculiarities.

**Affections of the Round Ligament** are not very uncommon. Non-obliteration of the canal of Nuck leads to the appearance of a *congenital inguinal hernia*, which is very frequent in girls and young unmarried women. In the operation required for its cure the round ligament is included in the ligature which encircles the neck of the sac. A *hydrocele* of the round ligament is due to a partial obliteration of the same structure, the patent portion becoming distended with a serous exudation. It presents as a tense, rounded swelling just below the external abdominal ring or in the inguinal canal, and is treated by dissecting it away. We have also met with a case of



bilocular hydrocele, in which an external cavity communicated with a large pelvic collection of fluid enclosed in a serous membrane. *Tumours* of the round ligament are unusual, but occur in the form of lymphangioma and fibro-myoma. An interesting instance of the latter was seen in a woman who was also the subject of uterine fibro myomata necessitating hysterectomy. The tumour of the round ligament was as large as an orange.

**Uterine Displacements**—The maintenance of the uterus in its normal position of slight anteversion is due to the associated influence of many diverse factors. Displacements are caused by many lapses from the normal condition, e.g., lack of support, as by rupture of the perineum, increased pressure from above, increased weight of the uterus, as from subinvolution after pregnancy, chronic inflammation or the presence of tumours, the traction of adhesions resulting from pelvic cellulitis, etc. The most common displacements are forwards, constituting anteversion or ante flexion, backwards, in the form of retroversion or retro flexion, and downwards, giving rise to prolapse or procidentia.

It is unnecessary to enter into the symptoms and ordinary treatment of these conditions, but the operative treatment of them requires notice.

Anterior displacements require no external operative treatment.

Posterior displacements are not unfrequently dealt with by operations through the anterior abdominal wall. Two chief methods are employed, viz., shortening the round ligaments and hysteropexy. *Shortening of the round ligaments* can be undertaken as an extra- or as an intra-peritoneal procedure. (1) Alexander's operation is extra-peritoneal, and suitable only for uncomplicated cases. The inguinal canal on each side is exposed and the external oblique slit up, the round ligament is identified, isolated, drawn taut, and the slack portion cut away, the posterior end is then fixed in the canal by sutures, which also serve to close it, the external oblique is also carefully sutured. (ii) In the intra-abdominal operation a complete investigation of the pelvic viscera is possible. A small median incision is made, the round ligament on either side is isolated, doubled over, and stitched to itself so as to remove all slackness. This latter operation is probably much the more satisfactory of the two. Of course, the additional use of a suitable pessary may be desirable.

*Hysteropexy*, or the fixation of the uterus to the anterior abdominal wall, is a procedure that must be cautiously undertaken in married patients who have not reached the climacteric. An incision 2 or 3 inches in length is made immediately above the symphysis, and the fundus uteri is drawn forwards by a volsellum. Three silkworm gut stitches are inserted through the abdominal parietes and peritoneum, and also through the body of the uterus just posterior to its axis. The stitches should include about  $\frac{3}{4}$  inch of the uterine wall in their grasp, and go about  $\frac{1}{8}$  inch deep. On drawing them tight, the uterus is fixed forwards against the abdominal wall and contracts adhesions. In some cases it may be desirable to scarify the uterine

wall before tying the stitches, so as the better to determine adhesions. As a general rule the adhesions stretch somewhat, and hence allow a certain degree of play, but without the likelihood of a return of the displacement.

**Prolapse of the Uterus** is most commonly associated with a ruptured perineum and chronic metritis. The anterior vaginal wall often gives way first and brings down the bladder, causing considerable dysuria or vesical irritability, and then the uterus itself

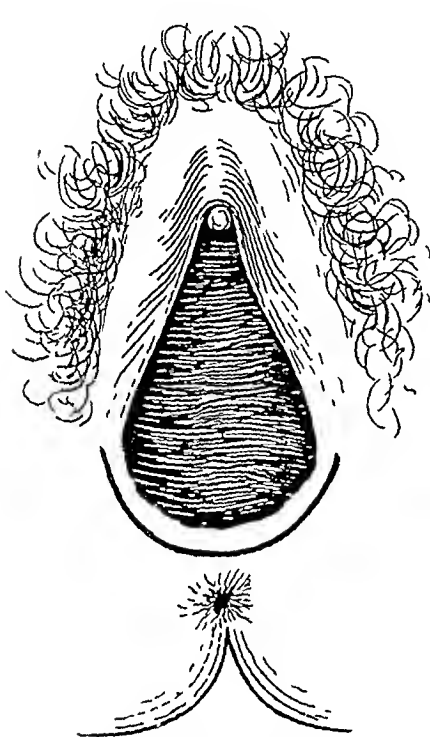


FIG 468 —INCISION FOR REPAIRING RUPTURED PERINEUM

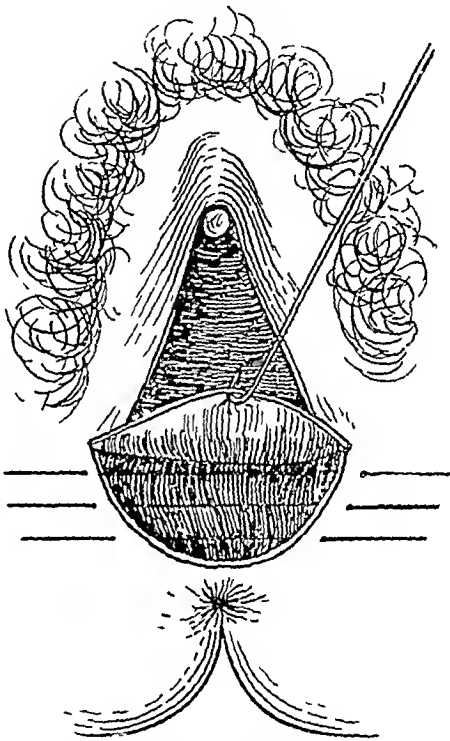


FIG 469 —VAGINAL FLAP DISSECTED UP FROM RECTO VAGINAL SEPTUM AND DRAWN FORWARDS

Some of the sutures are introduced

descends, and may even protrude from the vulva, the vagina being turned inside out, and its walls becoming dry like skin, and perhaps ulcerated from persistent irritation. **Treatment** varies according to the condition present and with the causes. The uterus, if enlarged and inflamed, may need to be curetted so as to diminish its bulk and weight. The perineum, if defective, must be repaired by one of the many forms of perineoplasty now in vogue. Possibly the introduction of a suitable pessary may suffice to keep the uterus in place for a sufficient time to allow the uterine supports to regain their tone. In some cases hysterectomy will be indicated, but in the worst forms vaginal hysterectomy, combined with some operation to diminish the size of the vaginal canal, may be required.

The operation for *repairing a ruptured perineum* necessarily varies with the extent and completeness of the tear. Obstetricians should always endeavour to stitch up these ruptures immediately after labour, as the parts are then very insensitive, owing to the stretching which they have suffered, and patients are very loth to undergo a secondary operation soon after. The plan usually adopted for remedying a defect which does not quite extend to the anus is indicated in Figs 468-470. An incision is made skirting the posterior

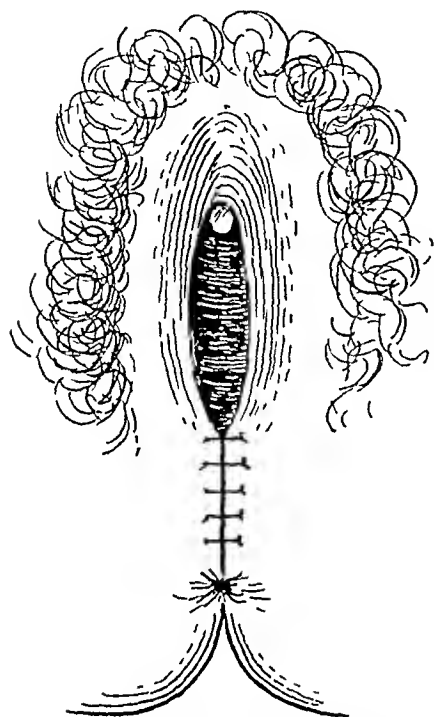


FIG 470 — OPERATION FOR REPAIRING A RUPTURED PERINEUM COMPLETED

vulval margin, and extending forwards on either side to the terminations of the nymphæ. By deepening this the posterior vaginal wall can be separated from the rectum, great care being taken not to encroach on either cavity and the flap thus produced is drawn forwards. The wound is then stitched up transversely, and an effective perineal body produced. A more extensive intra-vaginal operation is needed when the rent involves the anal orifice.

### Uterine Tumours

**Fibro myomata** are by no means uncommon, developing during sexual activity, and causing symptoms partly from their location in the uterus, partly from the size which they may attain. Any part of the uterus may be affected primarily, but they generally originate in the substance of the wall, and that usually the posterior wall, if they remain in this rela-

tion, they are known as *interstitial* or *intramural* fibroids (Fig 471, 1). When they are situated near the inner or outer uterine wall they may project either into the uterine or peritoneal cavities, constituting the *submucous* (2) and *subserous* (3) fibroids. Occasionally they become pedunculated, and then a *fibroid polypus* of the uterus may develop, and project through the os into the vagina, where it may undergo strangulation or torsion, and may slough away or become acutely inflamed. A pedunculated subserous fibroid may similarly become twisted or inflamed, and then may either slough, or may gain adhesions elsewhere, *e.g.*, to the omentum, and finally become separated from the uterus.

The *actual structure* of these tumours varies slightly, but they are all more or less of a fibro myomatous nature, *i.e.*, they consist of

muscle fibres similar to those of the uterus, with a varying amount of fibrous stroma and bloodvessels. Occasionally they are very hard and not specially vascular, in other cases they are more soft and more vascular, and then usually grow more quickly. They are surrounded by a capsule of varying density, which is often the seat of many enlarged veins, and if these are ulcerated into, considerable hæmorrhage follows. The uterus generally becomes hyperæmic and enlarged, and the mucous membrane thickened, not unfrequently endometritis is present, and the inflammation may spread up to the tubes, causing pyosalpinx.

Various secondary changes may occur in uterine fibroids. They may become *adenomatous*, or undergo *cystic degeneration*, as a result of defective nutrition, and that generally in young people, fibrocystic disease of the uterus is thereby determined. Occasionally in old women, where the evolution of the growth has long ceased, *calcareous degeneration* occurs, and the growth is converted into a stony mass. *Inflammation and pyogenic infection*, with perhaps abscess formation, may follow abrasion of the mucous membrane with a sound, and *sloughing* of the growth may result either from an inflammatory attack or from defective blood-supply. It is possible that *sarcoma* may supervene in some few cases, but the association is not yet absolutely proven.

The **Symptoms** vary much in different cases, but are mainly those of hæmorrhage and pressure. *Hæmorrhage* occurs either as a prolongation of the normal menstrual periods (menorrhagia), or as a chronic and persistent effusion of blood (metrorrhagia). It may be absent in subserous and interstitial fibroids, and is most marked in the submucous variety, in which the endometrium is congested and succulent. The amount of blood lost may drain the patient, who looks anæmic and dehydrated. There may be but little *pain* in the subserous variety, unless the growth becomes twisted or impacted in the pelvis. When the tumour projects upwards into the abdomen, nothing but a sense of weight is experienced unless the size is so great as to encroach seriously on the viscera. When the growth is mainly pelvic, and especially when a fibroid of the cervix extends sideways into the broad ligament, or when impaction occurs, the symptoms may

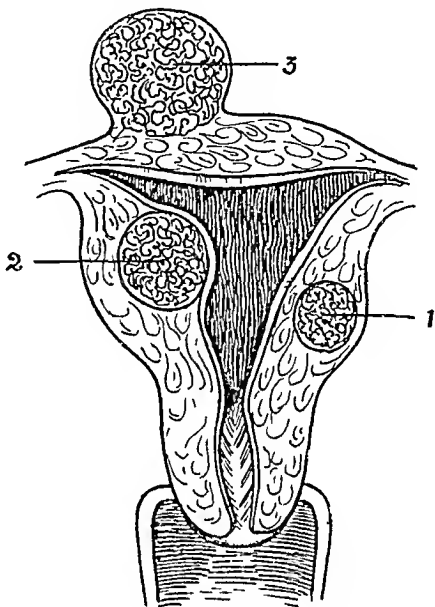


FIG 471 —DIAGRAM OF UTERUS WITH FIBRO-MYOMATA

1 Interstitial fibroid 2, submucous fibroid, 3, subserous fibroid

be very distressing. Vesical irritability may be very marked, and micturition may be painful and difficult. Tenesmus or constipation may arise from pressure on the rectum, hydronephrosis, when the ureters are compressed, and severe neuralgic pain down the leg, should the pelvic nerves be encroached on. The presence of a polypoid submucous growth is likely to cause violent expulsive contraction of the uterus.

The **Diagnosis** is made by palpation, digital examination, and the use of the sound. Bimanual examination should reveal the size and shape of the uterus, and much useful information can often be obtained by a combined vaginal and rectal examination. The sound will determine the increased length of the uterine canal, which is often in addition twisted.

The **Prognosis** has to be considered carefully in every case before determining for or against operative treatment. The majority of the cases improve at the menopause, the growth shrinking and the hæmorrhage ceasing, exceptions to this rule are, however, not unknown. It is therefore obvious that if the patient is approaching the climacteric and the symptoms are not grave, it may be advisable to wait for that event. On the other hand, if the condition occurs in a young woman, and especially if the hæmorrhage is sufficiently severe to necessitate prolonged rest and more or less chronic invalidism, operation is certainly desirable. Of course, the existence of severe hæmorrhage, or of symptoms of pelvic pressure, would at all ages justify operation.

**Treatment**—If the symptoms are not such as to warrant operation, all that is required is that the patient should rest at the menstrual periods, and that ergot and iron should be administered if necessary.

*Operative Treatment* consists in either the enucleation of the tumour or the extirpation of the uterus, and the removal of the ovaries and tubes.

(1) **Myomectomy**, or the enucleation and removal of the tumour apart from the uterus, is only suitable under special circumstances. When the growth projects into the uterus or vagina as a polypus, the vaginal route may be adopted, the cervix is dilated if need be, and after incising the mucous membrane, the growth can be enucleated by the finger. A subserous fibro-myoma can similarly be removed without difficulty if it be thought desirable. Not unfrequently this condition is met with in laparotomies for other conditions, and the surgeon may think it desirable to remove the growth. A longitudinal incision down to the capsule and a sweep round of the finger usually suffices to enucleate the tumour, and that with very little bleeding. Two or three deep stitches may be introduced into the uterine substance, and the peritoneum adjusted and apposed by superficial stitches. No drainage is required as a rule.

(2) **Abdominal Hysterectomy** for fibroids is a most successful procedure. It may suffice to remove the organ through or above the cervix (supra-vaginal hysterectomy), or it may be needful to include the cervix in the mass that is removed (pan-hysterectomy). The

procedure is identical up to a certain point, but the latter operation is rather the longer, and the dangers are a little greater

The patient must be carefully prepared as for any other abdominal operation (p 960), but in addition the pubes and vulva must be shaved and thoroughly purified, the vagina should be douched for some days previously, and an antiseptic dressing worn, and if need be the uterine canal should be curetted and disinfected with some powerful antiseptic

After anæsthesia has been induced, the Trendelenburg position is adopted, and an incision of suitable length made in the median line. The parts are then carefully explored, and if no adhesions exist,

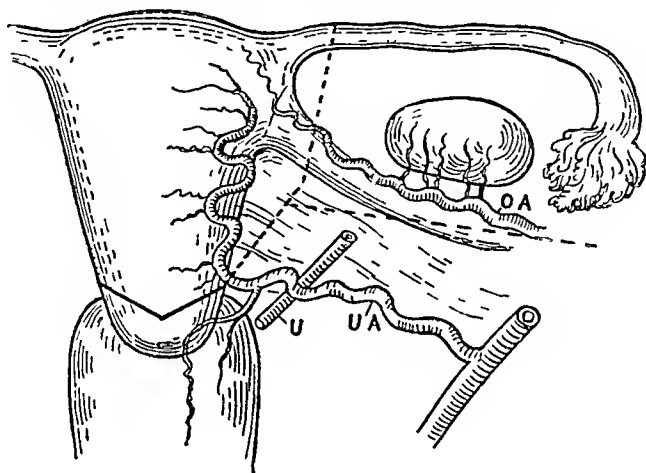


FIG 472 —DIAGRAM OF UTERUS, VAGINA, AND BROAD LIGAMENT, SEEN FROM IN FRONT

O A , Ovarian artery, U A , uterine artery U , ureter The dotted lines represent the division of the broad ligament in hysterectomy according to whether or not the ovary is removed The continuous dark lines crossing the uterus indicate the incisions through the uterine substance in supra-vaginal hysterectomy

an abdominal cloth is packed in over the intestines in order to protect and keep them from exposure and injury If adhesions to omentum or gut are present, they must be carefully divided, it is, of course, most desirable that a complete peritoneal envelope should be secured for any adherent organs, omental grafts may be sometimes useful in this direction The uterus is now lifted up and drawn into the incision, and for this purpose Doyen's myoma screw is most useful

The broad ligaments are then examined, and a decision made as to whether or not the ovaries and tubes are to be saved It is certainly desirable that in a young woman an effort should be made to retain at any rate one ovary, thereby avoiding the nervous symptoms often determined by an acute artificial menopause The lines of section of the broad ligament under these two conditions are indicated diagrammatically in Fig 472

A pedicle needle carrying a sufficient length of well-boiled silk is carried through the round ligament so as to secure the ovarian artery and veins, and tied as far away from the uterus as possible, a broad ligament clamp may then be placed in position close to the uterus so as to prevent venous regurgitation, and the broad ligament is divided halfway down. It is often possible and desirable to pick up the divided end of the ovarian artery on the face of this section and secure it separately, whilst the little artery which accompanies the round ligament should also be carefully secured. The ovarian artery on the other side is next dealt with in a similar fashion. A transverse cut is now made across the front of the uterus, involving merely the serous membrane, and connecting the two ends of the incisions in the broad ligaments, the peritoneum below this transverse cut is detached, together with the bladder, from the cervix, and the intraligamentary space is thereby opened up on either side. In this will be found the uterine vessels, and it may be possible to see and isolate the uterine artery before securing it by ligature. Care must be taken in this part of the operation to keep close to the uterus, as the ureter comes forwards from behind under the uterine artery to reach the bladder, lying about the level of the os internum. The uterine vessels are in this way carefully secured and divided.

The uterus is now merely held by the connection between the vagina and cervix, and the peritoneal reflection in Douglas's pouch. If a supra-vaginal operation will suffice, the surgeon cuts across the neck of the uterus in such a way as to fashion two flaps, and finally the peritoneum behind is also divided. A few small vessels will probably need to be secured on the face of the uterine stump. This having been effected, the uterine flaps are stitched carefully together so as to bury the open cervical canal, the uterine stump is then covered in by uniting the divided portions of peritoneum. This line of sutures is carried up on either side so as to secure the two layers of the broad ligament, the final result is that the pelvic floor is covered in by a continuous layer of peritoneum, showing a closed incision which runs transversely from one side to the other. The usual peritoneal toilette follows, and the abdomen is generally closed entirely, no drainage being required.

When the fibroid tumours involve the cervix, it may be necessary to perform pan-hysterectomy. The operation follows along the lines indicated above, up to the securing of the uterine vessels. It is then advisable to open into the posterior vaginal cul-de-sac, and enucleate the cervix from its surroundings from behind forwards, keeping very near to the uterus at the sides so as to avoid the ureters, and keeping clear of the bladder in front. Several vessels derived from the vaginal arteries will require to be secured in this proceeding. The wound in the pelvic floor is closed much in the same way as before, but not so completely as regards the vaginal walls, a small lamp-wick drain of iodoform gauze being introduced between them. The peritoneum is sutured continuously over the gauze, and up on either side to the upper extremity of the broad ligament.

In either case a pad of antiseptic dressing is maintained over the vulva for a time, and in pan hysterectomy it is advisable to douche the vagina daily. The gauze packing is removed on the third day, and another strip introduced. The results of this operation are most satisfactory, and the death rate comparatively small.

(3) **Double Salpingo-oophorectomy** (removal of ovaries and tubes) was at one time much practised in the treatment of uterine fibroids, and certainly had the effect of checking hæmorrhage and diminishing their growth by determining an artificial menopause. At the same time, the patient is not relieved of the incubus of the growth, and hence the operation is now but seldom employed, except as a part of a complete hysterectomy.

**Sarcoma of the Uterus** is not of very common occurrence. It may be a secondary development following on fibro myomata, or may be primary. In most cases it occurs as a solid, firm tumour, consisting of spindle cells, but more vascular and a little softer than the majority of fibroids, in others it is of a softer consistency, and may be associated with myxomatous development. It almost always involves the body of the organ, the cervix being unaffected, and it may either attack the mucous membrane primarily as a diffuse infiltration, or constitutes a more localized growth in the muscular tissue. Secondary deposits occur in the vagina and elsewhere, and the case runs a more rapid course than a simple fibroid, although the symptoms are much of the same type. There is, however, more discharge from the vagina, which may contain débris of the growth, and becomes somewhat offensive. **Treatment** consists in pan-hysterectomy.

**Carcinoma of the Uterus** is the most common form of cancer in the female, accounting for over 30 per cent of the deaths from this disease. It follows the usual rule as to age, being uncommon under thirty years, and most frequently seen between the ages of forty and fifty. It generally occurs in multiparæ, and is probably associated with lacerations of the cervix and inflammatory erosions dependent thereon. The site of origin is usually the cervix, the body being comparatively seldom affected primarily.

Cancer of the cervix starts (i) as a nodular overgrowth of the glands imbedded in its substance, (ii) as an epithelioma of the vaginal portion, projecting into that passage as a malignant papilloma, or (iii) as a diffuse affection of the cervical epithelium and its glands, and hence is most frequently of a columnar celled type. In all these cervical forms the vagina is early affected, the disease spreads more slowly up towards the body of the uterus. The arrangement of vessels and lymphatics will explain the fact that invasion of the broad ligaments is early, these structures become infiltrated and rigid, fixing the uterus, and pressure phenomena upon the rectum, bladder, or pelvic vessels and nerves, will sooner or later be manifested. Destructive ulceration follows, and the bladder or rectum may be laid open, and empty their contents into the vagina, which in the worst cases becomes an evil-smelling cloaca. Adhesive



inflammation serves to protect the peritoneal cavity, which is not often opened up

Carcinoma of the body of the uterus starts in the mucous membrane and its glands, and rapidly disseminates and infiltrates the whole cavity, it also is of a columnar-celled type. The whole organ may become hollowed out by ulceration, constituting a sloughing cavity from which an abundant hæmorrhagic discharge escapes.

In all cases lymphatic dissemination follows, involving the pelvic glands first, and later on the iliac, and possibly even the inguinal. Compression of the ureters may cause hydronephrosis, the iliac vessels may be compressed and lead to œdema of the legs, and pulmonary embolus secondary to venous thrombosis has been known to cause death. General dissemination to the viscera is not common.

The chief **Symptoms** of uterine cancer are pain, hæmorrhage, and an offensive discharge. Pain is unfortunately not an early manifestation in most cases, and hence the disease has often gained a good hold before the patient comes under observation. As soon as the body of the organ is attacked, or the extra-uterine cellular tissue, it begins to trouble the patient, it is of an aching, gnawing, or boring character, and in the later stages may be so appalling in its severity as to necessitate the injection of huge doses of morphia. As a general rule, it is most marked when there is comparatively little destructive ulceration. Referred and sympathetic pains in back, breasts, and legs are also much complained of. The hæmorrhage may at first be merely an exaggeration of normal menstrual periods, but later on the loss of blood is often continuous and may be associated with horribly offensive muco-pus and cancerous débris. The appearance of a hæmorrhagic discharge after the menopause should always determine a careful local examination of the pelvic viscera. Loss of flesh, debility, and the ordinary phenomena of a cancerous cachexia, are gradually developed, and to these may be added special symptoms due to implication of the bladder and bowel.

On *vaginal examination* the physical signs corresponding to the type of disease make themselves evident. There may be merely a nodular thickening of the cervix, or an ulcerating papillomatous mass, like a cauliflower, may project into the vagina, invading the walls of this tube, or the finger may pass through the open os into a ragged hollow cavity lined by an ulcerating mass of new growth. The most careful attention must be given as to the lateral extension of the growth into the broad ligament, whether the uterus is mobile or fixed, and whether the vaginal wall is much involved, as it is upon these facts that the possibility or not of operation depends. It is useless to attempt removal when the broad ligaments are badly invaded, or if the vaginal wall is extensively implicated, or the uterus firmly fixed to bladder or rectum.

In early doubtful cases where the os is ulcerated to a slight extent, a portion of the growth should be snipped away, and submitted to microscopical examination.

**Radical Treatment** is only practicable when the disease has not

extended too far. Formerly gynaecologists used to practise amputation of the cervix when the disease was apparently limited to this region. In the light of modern pathology such a procedure is unscientific and insufficient, and clinical experience has shown that the only operation which should be considered is complete hysterectomy.

**Hysterectomy** for carcinoma uteri may be performed by the vaginal route or through the abdomen. (1) The *vaginal* operation is possibly a little safer, but has the objections that the broad ligaments cannot be dealt with quite so satisfactorily, and that should adhesions exist it will be difficult or impossible to deal with them. However, in simple early cases it will suffice, and, indeed, when the disease is so extensive as to need more than a vaginal procedure, it has probably gone so far as to be practically inoperable. For details of this operation, gynaecological text-books must be consulted. (2) *Abdominal* hysterectomy may be occasionally required, but operations which include removal of pelvic glands and extensive dissections will probably do little good, and may, indeed, aggravate the trouble by opening up fresh planes of tissue to infection. In any case the whole uterus must be removed, and it is advisable to thoroughly curette and purify the os and uterine cavity before commencing. (3) A combined vaginal and abdominal operation is sometimes undertaken when the disease has attacked the vaginal wall beyond the margins of the cervix. The greatest care must be taken not to injure the bladder or rectum, and not to divide or ligature the ureters.

**Palliative Treatment** in inoperable cases consists in staving the hæmorrhage, keeping the parts as free from sepsis as possible, and combating pain by morphia. In some cases it may be permissible to curette the diseased structures, thereby removing protuberant masses which interfere with the escape of the discharge.

Finally, a word must be added to emphasize the fact that the constant association of this disease with a torn and eroded os suggests the possibility of *prevention* by attending to such lesions and not allowing them to persist indefinitely without treatment.

**Chorio epithelioma** (*Syn.* Deciduoma malignum, Syncytioma maligna, etc.) is an interesting condition to which considerable attention has been directed of late. It consists of an overgrowth of the chorionic villi, which constitute a soft bleeding tumour invading and thinning the uterine wall, and insinuating itself into the venous channels, so that general dissemination of the growth is an early manifestation, the lungs being usually involved first. The growth is a soft succulent papillomatous looking mass involving the body of the uterus and not unfrequently the fundus and bearing a close resemblance in structure and physical characters to a vesicular mole. In fact, it may be looked on as a malignant form of this structure. The characteristic histological feature is the presence of large syncytial cells derived from the outer layers of the chorionic villi, which appear as masses of protoplasm containing many dark nuclei. In addition to these are many smaller cells, irregular in shape, unusually rich in glycogen, and in which division by karyokinesis is the rule. It is unusual to be able to demonstrate typical chorionic villi in the mass, but the peculiar cells are exactly similar in nature to those which occur in the villi. Ovarian changes are not unfrequently observed, in the shape of multiple cysts due to degeneration of the corpora lutea.

The *clinical* features of a chorio epithelioma are fairly characteristic. Occasionally the disease follows a normal pregnancy and is apparently due to the

persistence of a portion of the placental tissue, which takes on malignant action of this peculiar type. In the great majority of cases, however, it is preceded by a miscarriage at a fairly early date, and perhaps a vesicular mole of some size is removed. The hæmorrhagic discharge does not cease, but continues and may become exaggerated. Retention of placental tissue is usually diagnosed, and as a rule the uterus is curetted, if on microscopic examination of the scrapings the characteristic cells of a chorio epithelioma are found, no delay is permissible, but the uterus must be removed at once. Should the case be left, the hæmorrhagic discharge increases, the uterus becomes enlarged, and evidences of secondary deposits appear, especially in the lungs. The nature of this growth is very malignant, and the patient quickly succumbs. *Treatment* consists in abdominal hysterectomy, which should include the ovaries, and if the case is taken before dissemination has occurred, there is good hope of success.

### Affections of the Fallopian Tubes

**Pyosalpinx**, or an accumulation of pus in the Fallopian tube, is the result of infection of its lining walls either with gonococci (the



FIG 473 —PYOSALPINX, SHOWING THE FALLOPIAN TUBE BENT OVER ON ITSELF (KING'S COLLEGE HOSPITAL MUSEUM)

1, Ovary, 2, uterine end of tube

commonest cause), or with pyogenic organisms spreading from a septic uterus after a miscarriage or confinement, or occasionally with the tubercle bacillus. The process is usually chronic or subacute, if it should commence acutely, the symptoms are so blended with those of the accompanying uterine or peritoneal inflammation as to be scarcely distinguishable. Both tubes are usually affected.

The inflammation, whether acute or chronic, usually results in blocking, and perhaps complete and permanent closure, of both ends of the tube, the abdominal ostium may be closed by fibrin or by the adhesion of the fimbriated extremity to surrounding viscera. Distension of the tube follows, and it frequently becomes elongated and tortuous (Fig 473), it may contain a considerable quantity of pus, which, though containing organisms at first, may in time become sterile, the germs dying out. The distended tubes gain

adhesions to surrounding parts as a result of plastic peritonitis, and the abscess may burst either into the vagina, into one of the surrounding viscera (bladder, rectum, or small intestine), or into the general peritoneal cavity

**Clinical History** —In the *acute* stage, which is occasionally seen in gonorrhœal and septic cases, the symptoms are practically those of pelvic peritonitis. The patient lies in bed with the knees drawn up, the temperature is raised, and there may be one or more rigors, the lower part of the abdomen is intensely tender, and vaginal examination reveals little but a generalized painful rigidity and infiltration of all the parts. Under suitable treatment these acute phenomena gradually subside, and the patient then begins to manifest the signs of a *chronic* salpingitis, which in the majority of cases constitute the initial symptoms. Pain is perhaps the chief manifestation, and this is sometimes of a continuous dragging type, referred to the back and increased on any exertion, or it may only be noticed to any extent at the periods. Not unfrequently the patient is laid up for a week or ten days at a time with these phenomena. If many adhesions are present, micturition and defæcation may also be very painful. The patient is unable to take much exercise, and may walk in a peculiarly cautious manner, bending forwards so as to relax the abdominal muscles and possibly guarding the lower abdomen with her hands. All these symptoms are increased at the menstrual periods, which are profuse and prolonged, and accompanied by some rise of temperature. When a well-marked collection of pus is present, a hectic type of temperature may persist, and the patient shows signs of septic poisoning. The bursting of the abscess into the vagina or one of the viscera may cure the case, if a sufficient exit to the pus is thereby provided. Vaginal examination demonstrates the enlarged and tender tubes, the uterus itself loses some or all of its mobility, and the vaginal vault may feel hard and rigid.

**Treatment** in the acute cases consists of rest in bed, fomentations to the abdomen and hot vaginal douches, together with opium, if need be, for the pain. In the great majority of cases, which are chronic, the only treatment is removal of the tube and its contained pus. This may be a simple procedure, or an operation of the greatest difficulty, according to the number and nature of the adhesions present. It must be remembered that, although the pus in an old-standing case is likely to be sterile, one cannot rely on this occurrence, and hence every precaution must be taken to guard against infection. It may be possible in some cases to save one or both ovaries, and this is certainly desirable in order to protect the patient from the discomforts of an acute menopause. In a few favourable cases the pus can be reached through the vaginal vault, and an intra-peritoneal operation is thereby avoided, but the indications must be very clear and precise before this method of approach is adopted.

**Hydrosalpinx** is a condition in which the Fallopian tube is distended with a mucoid secretion, due to the existence of a chronic inflamma-

tion, which has extended from the uterus, and led to the closure of the abdominal and vaginal openings of the tube. A collection of considerable size may result, and needs to be dealt with by laparotomy.

**Tubal Gestation** is a condition in which the impregnated ovum commences to develop in the Fallopian tube instead of in the uterus. The causes of this condition are quite unknown, but it may be due to a kink or twist of the tube, whereby the onward passage of the ovum is prevented. Ectopic gestation also occurs within the peritoneal cavity or in connection with the ovary, but these conditions are always looked on as secondary to a primary tubal gestation, the foetus having escaped from the tube. Any part of the tube may be affected, and hence three forms are described, viz, (1) the interstitial or tubo-uterine, where the growth encroaches on the uterine wall, (2) the true tubal, and (3) the tubo-ovarian or infundibular, where the outer end of the tube is affected.

The muscular wall of the tube stretches and at first becomes hypertrophied, the mucous lining is turgid and congested, and transformed into a decidual membrane. In time the muscle fibres disappear and are replaced by fibrous tissue, and at the placental site atrophy occurs, so that sooner or later rupture of the tube follows, and then the ovum either escapes into the abdomen or into the substance of the broad ligament, and may die or continue its development, the placenta possibly gaining a fresh attachment to intestines or other structures. Concurrently with these changes in the tube, the uterus enlarges and becomes lined by a decidual membrane, but is relatively much smaller than usual, at five months it is a third smaller than in an intra-uterine pregnancy, and at full term is about 4 to 6 inches long. Not unfrequently the rupture of a tubal gestation is accompanied by the discharge of a complete cast of the uterus, from which a lochial secretion escapes for a time, and which undergoes involution.

The **clinical history** of an ectopic gestation varies very much in different cases. The general signs of pregnancy are present, but may not be quite typical, the breasts are enlarged, vomiting may occur, but the menses are not always completely stopped. Examination in the early stages might indicate the presence of a well defined moveable mass on one side of the uterus, if the gestation be unruptured.

In the early months the great danger is that of *rupture* of the tube, and possibly death from hæmorrhage. Two forms are described.

1. **Primary Intra-peritoneal Rupture**, which usually occurs about the sixth to the eighth week. The tube gives way before the increasing tension of the ovum, and looks almost as if torn in half. Severe hæmorrhage follows, and the patient either succumbs, or recovers to suffer, perhaps, from a similar condition a few days later. In a few cases the ovum regains a vascular connection in the abdomen and continues its development, but generally the pregnancy comes to an end and the ovum dies. The *symptoms* are alarming in the extreme. The patient is seized with severe cutting intra-

abdominal pain which is referred to the pelvis, and becomes white, faint, and collapsed. The lower part of the abdomen is exquisitely tender, and the muscles are held rigid and tense. The actual presence of blood in the peritoneal cavity can rarely be demonstrated, but the amount lost is often very great. If the patient survives, she is left in a feeble condition, and often suffers from pyrexia for some days, whilst the pain gradually diminishes. A recurrence of the bleeding may bring the patient into the direst peril, but if it does not recur, absorption commences and may progress uninterruptedly, or a pelvic hæmatocele may result, and this may persist indefinitely or undergo suppurative changes and require operation.

2 **Primary Extra-peritoneal Rupture** occurs when the chief development has been downwards and inwards between the layers of the broad ligament. The catastrophe is in these cases somewhat later than in the former class, rupture being delayed sometimes till the seventh to the twelfth week. The loss of blood is necessarily not so great, and the general symptoms are less severe. On vaginal examination the blood tumour can probably be detected by the side of the uterus. The ovum usually dies, and absorption may follow, but not uncommonly sepsis supervenes and an abscess forms, in other cases a secondary rupture into the peritoneal cavity follows, being associated with the ordinary symptoms of this condition.

Comparatively few ectopic pregnancies continue *after the fourth month*, but should the ovum escape the earlier dangers that surround it, its development may continue either in the tube (very rare) or in the abdominal cavity. The usual phenomena of pregnancy are present, but with modifications. The breasts are less full than usual, the movements of the child under the abdominal wall may be too obvious to the naked eye, the abdomen is asymmetrically enlarged, and the long axis may even be transverse, palpation of the fœtus may be unduly easy, and the placental souffle exaggerated or misplaced. At full term, or possibly a month or two before it, a form of spurious labour occurs, followed usually by the death of the fœtus. The abdominal swelling diminishes in size, and the uterus undergoes involution with a lochial discharge. The fœtus is either encapsuled, and may be either mummified, calcified (then constituting a *lithopedion*), or transformed into adipocere, suppuration sometimes ensues, and the disintegrated fœtus may find its way out through abscesses which burst into the hollow viscera or externally.

**Treatment of a Ruptured Tubal Gestation**—In these cases the danger to the patient is that of hæmorrhage, and it is obvious that the rules that guide us elsewhere apply here—viz, that the bleeding point should be exposed and the torn vessels secured. Owing to the fact that the hæmorrhage is concealed, it is possible for the patient to pass into such a condition of collapse as to render operative treatment almost impracticable. In such cases it may be feasible to improve her condition by the infusion of salt solution so as to justify operation. In other cases where the patient has had one attack of

hæmorrhage from which she is recovering, the question of operation is quite open to discussion on the one hand are the facts that no further trouble need arise, and that the hæmatocele may be absorbed on the other hand the hæmorrhage may recur, or the hæmatocele may suppurate. It is probable that operation in all cases is perfectly sound advice, especially as one cannot be always certain that the ovum is dead (although the passage of a cast of the uterus suggests it), and it is desirable that it should not continue its development in the peritoneal cavity. In careful aseptic hands the risks of operation are very small. It goes almost without saying that if a diagnosis of tubal gestation is made prior to rupture, the tube should be at once removed.

Operation for *intra-peritoneal* rupture must not be delayed, possibly it may be wise to commence intravenous infusion before opening the abdomen, and to allow an assistant to continue the process. The patient is placed in the Trendelenburg position, a median incision is made above the pubes, an abundant escape of blood and clots is likely to follow, but the hand is thrust firmly down so as to distinguish the uterus, and thence passes to the ruptured tube, which must be grasped by the uterine attachment and a hæmostatic clamp at once applied, the other end is then sought for. Both portions are removed, and the bases securely ligatured. The intra-peritoneal clots may be cleansed away or left according to the condition of the patient, and the abdomen either closed entirely or a drain inserted. The subsequent treatment is that for all forms of hæmorrhage.

The operation for an *extra-peritoneal* rupture is slightly different in its characters, since it is usually not undertaken for hæmorrhage, but in order to remove the products of gestation, to relieve the patient from pain, and to prevent a long and tedious convalescence whilst the hæmatocele is absorbing. The possibility that sepsis may have already reached the sac must not be lost sight of. A median laparotomy is performed in the Trendelenburg position, and the viscera securely walled off by sterile gauze. Intestinal adhesions may be present, and must be cautiously loosened so as to expose the sac of the hæmatocele. This may give way during the manipulations to separate the intestine, or may need to be incised or tapped with a trocar. The mass is then isolated, its vessels tied, and complete removal follows, or it may be necessary to evacuate the contents and drain or pack the cavity, especially when the blood has burrowed deeply into the pelvis between the layers of the broad ligament.

When suppuration has occurred, the abscess must be treated on the same principles as guide us in the treatment of a pelvic peritonitis. It may be possible to open and drain from the vagina, or the abscess may have to be dealt with from above.

For the treatment of ectopic gestation which persists after the fourth month, we must refer readers to larger textbooks.

### Cysts of the Ovary and Broad Ligament

Many different forms of cyst are developed in this region, and their origin from an embryological standpoint has been already alluded to (p 218) The following classification may, however, be useful

#### I Cysts directly connected with the Ovary

- 1 True ovarian cyst, single, multiple, or proliferating
- 2 Paroophoritic cyst with papillomatous developments
- 3 Corpus luteum cysts
- 4 Ovarian dermoid or teratoma
- 5 Malignant ovarian cyst (usually carcinomatous)
- 6 Ovarian hydrocele

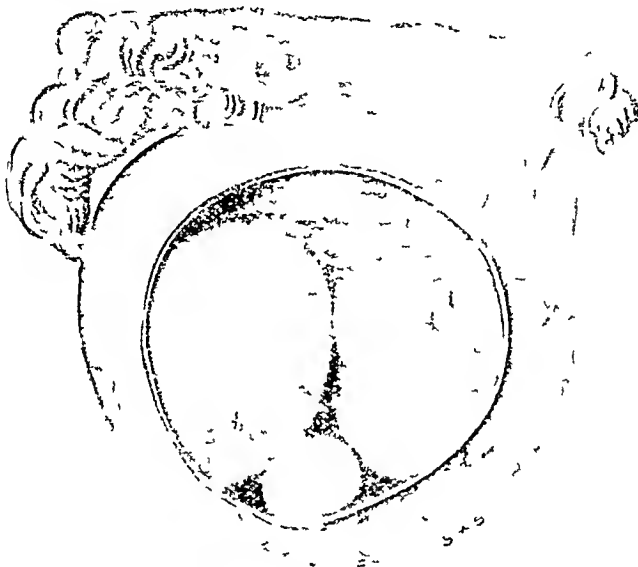


FIG 474 —PROLIFERATING CYSTO ADENOMA OF THE OVARY (KING'S COLLEGE HOSPITAL MUSEUM)

The main cyst has been laid open to show the smaller cysts which project into its cavity

#### II Cysts of the Broad Ligament

- 1 Parovarian cysts
- 2 Cysts of Kobelt's tubes
- 3 Cyst of Gartner's duct
- 4 Fallopian tube cysts
- 5 Lymphangiomatous developments

**True Ovarian Cysts**, or, as they should perhaps be better termed, the **cysto-adenomata of the ovary**, are usually multilocular swellings, involving one or both ovaries (more commonly the former), and arising from the tubular ingrowths of the ovarian epithelium or from the Graafian follicles. As the swelling increases, the walls between the loculi thin out and may be absorbed, but the usual appearance is that shown in Fig 474, where rounded cyst like masses are seen



projecting within the larger cyst, which has been laid open. The fluid is of a tenacious character, somewhat similar in type to mucin, and usually of a yellowish-white colour, if hæmorrhage has taken place into the cyst, the colour is of course modified.

The size of these cysto adenomata varies enormously, they may be small as an orange, or large enough to compress the abdominal contents and interfere seriously with respiration. The largest cyst of this type we have dealt with contained 32 pints of fluid, the patient was 65 inches in circumference, and her legs were dripping with dropsy, she had been unable to lie down in bed for many months.



FIG 475 — CYST OF OVARY (PAROOPHORITIC) WITH PROLIFERATING PAPILLOMATOUS INTRA-CYSTIC GROWTHS (KING'S COLLEGE HOSPITAL MUSEUM)

The walls of the growth vary in thickness and substance, sometimes there is a considerable mass of newly-formed epithelial tissue, which in time would undergo degeneration and form fresh cysts. The cyst is covered externally with peritoneum, and possibly adhesions to omentum or intestine may be present. The broad ligament and Fallopian tube become stretched by the traction and weight of the mass and constitute a well-marked pedicle, which contains the nutrient vessels.

**Paroophoritic Cysts** are very similar in character to the above, but contain intracystic papillomatous developments (Fig 475), which not unfrequently burrow through the cyst wall, and may invade the peritoneal cavity, and hence are semi malignant. The primary growth may be uni- or multilocular, and in some cases large thin-walled cysts develop containing large cauliflower-like excrescences, which are covered with columnar epithelium.

**Corpus Luteum Cysts** are usually multiple and not of great size, though occasionally they may be found as large as a fist. The fluid contained within is more or less thick, and dark in colour from blood extravasation, and the lining wall shows a definite overgrowth of lutein cells. The association of this type of overgrowth with deciduoma malignum has been already mentioned.

For **Ovarian Dermoids or Teratomata**, see pp 215 and 217. An ovarian dermoid is usually unilocular, it may manifest its presence at an early age, or not until middle life, it grows slowly, and is very liable to attacks of inflammation, probably resulting from partial torsion, and hence adhesions between it and other parts are not uncommon.

**Ovarian Hydrocele** is a condition, rarely observed, in which the ovary lies in a pouch in the broad ligament, the mouth of which becomes



FIG 476—CYSTS OF KOBELT'S TUBES (KING'S COLLEGE HOSPITAL MUSEUM)

1, Fallopian tube, 2, fimbriated extremity of Fallopian tube 3, ovary, 4, Kobelt's cysts

closed through the development of adhesions so that a collection of fluid can occur outside the ovary. It is not likely to attain great dimensions.

**Parovarian Cysts** result from distension with fluid of the parovarium or organ of Rosenmüller, which in reality is the atrophied remnant of the Wolffian body, traces of which can often be seen in the broad ligament. As the cyst gradually increases in size, the layers of the broad ligament are separated, and the ovary and tube are pushed up and stretched over the growth, which usually burrows deeply into the pelvis by the side of the uterus. The cyst is generally unilocular, thin-walled, and contains a clear limpid fluid. Its method of development explains the fact that it has no pedicle.

**Cysts of Kobelt's Tubes** (Fig 476) are frequently seen, and are of little significance. It is quite unusual for them to become large enough to cause symptoms.

**Clinical History**—It is unnecessary to discuss here *in extenso* the symptoms which arise in the earlier stages when the cyst is small and intrapelvic. Suffice it that some disturbance of menstruation may occur, usually in the direction of menorrhagia, and that there may be a sense of intrapelvic pressure or pain, and possibly some inter-

terence with the bladder or rectum, the latter may be more marked in the broad ligament cysts than in the true ovarian

The patient is most likely to come under observation when the growth has emerged from the pelvis and become abdominal, and possibly she may have noticed that the swelling appeared first on one side. As it increases in size, it becomes more mesial, and pushes up under the anterior abdominal wall, usually displacing the intestines backwards and towards the sides of the abdomen. Hence on inspection the projection of the growth can often be seen, and there is no bulging of the flanks such as occurs in ascites. Percussion elicits a dull note over the swelling, though the margins may be overlapped by intestine and give a semi-resonant note, the flanks are resonant, whereas in ascites the anterior abdominal wall is resonant, and the flanks and sides dull. Very little or no modification in the percussion note occurs on changing the position from the dorsal to the lateral decubitus, whereas in ascites this produces a marked alteration. On palpation the outline of the cyst may be easily tangible, and it may be felt passing down into the pelvis. A tap sometimes produces a fluid thrill, which is most marked in the unilocular parovarian cysts, and often absent in the multilocular variety, unless the front of the mass is constituted by a single large loculus. It may be possible to demonstrate that the mass is mobile, especially on bimanual examination. The growth is usually found to drag the uterus upwards, and does not project down into the fornices, hence the vagina often appears to be very long, and the cervix is sometimes difficult to reach. The uterus may be displaced laterally.

Pressure symptoms of various types arise, such as impaired digestion and constipation, leading to interference with nutrition, emaciation and debility, œdema of the legs is caused by pressure on the vena cava, the subcutaneous veins of the abdominal wall become prominent, and respiration may be considerably embarrassed. Should even a small ovarian cyst become impacted in the pelvis, all the evidences of pressure may be at once exaggerated, and both rectum and bladder are irritable.

**Complications** of various types ensue, and may quickly jeopardize the patient's life. (1) *Inflammation* arises from a variety of causes, e.g., traumatism or partial torsion, or the germs may gain access from some neighbouring viscus, e.g., the appendix or Fallopian tube. The trouble may be of a slight and localized character, and then merely a few adhesions are developed, or it may be a deep parenchymatous affection, followed by suppuration. The usual phenomena of intra-abdominal inflammation are manifested: the patient complains of pain, and lies with the legs drawn up, the temperature is raised, vomiting and possibly constipation are present, and on palpation the growth is tender, increased in size, and possibly less easily defined. If pus forms, it may escape into the peritoneal cavity or one of the hollow viscera. Even if recovery follows, extensive adhesions may ensue and lead to serious consequences.

(2) *Torsion* of the cyst is predisposed to by the existence of a

well-marked elongated pedicle, it is impossible in the presence of extensive adhesions. It is probably determined by irregular contractions of the abdominal muscles, and the final disturbance may be caused by definite traumatism. From the fact that in acute cases the pedicle is found twisted on itself two or three times, it is obvious that slight attacks must have preceded the final outbreak of symptoms, and many of the slighter attacks of inflammation (usually supposed to be peritonitic in type) are probably of this nature. Finally, the torsion becomes so severe that the circulation in the cyst ceases, and strangulation ensues. An aseptic peritonitis follows, and unless relief is given in time death from generalized peritonitis and intestinal paralysis follows. The cyst becomes enlarged and engorged with blood, hæmorrhage may occur into its substance, and gangrene is likely to follow. The symptoms may come on suddenly after some effort, or there may be no obvious cause. Pain of a severe character is complained of, followed by shock, the tumour is obviously increased in size, tender and tense, vomiting and constipation suggest the existence of an acute intestinal obstruction, and if the case is not seen till late and there is no definite history of a cyst to be obtained, a diagnosis may be difficult or impossible apart from an exploratory operation.

(iii) *Rupture* of the cyst may be spontaneous from gradual thinning of the walls, or due to traumatism. The results vary with the contents. A sudden rupture leads to severe pain and shock, this may be followed by inflammatory phenomena and peritonitis if the contents are of a sticky colloidal character, but, when limpid and serous, the fluid may be absorbed, and no harm follows. The cyst itself collapses, and is likely to develop adhesions, but the secreting substance persists, and the cavity may fill up again.

It is impossible to discuss fully here the **Diagnosis** of ovarian cystomata, and it must suffice to point out that the passage of a catheter eliminates the question of a distended bladder, that careful attention to the percussion phenomena, both in the dorsal and lateral decubitus, should suffice to determine the existence or not of ascites, and that vaginal examination and the passage of a uterine sound should exclude uterine conditions that might be mistaken. Before the introduction of a sound it is of course essential to exclude the possibility of pregnancy. The absence of changes in the cervix uteri and in the breasts, the non-existence of a uterine souffle on auscultation, or of a history of amenorrhœa, morning sickness, etc., should suffice to determine the absence of this latter condition.

**Treatment** for nearly all varieties of ovarian cyst is the operation of *Ovariectomy*, first performed in 1809 by Dr Ephraim McDowell in Danville, Kentucky, and that with success. The essential idea of the operation is the removal of the cyst, and this may be accomplished either with or without tapping. The size of the growth will to some extent determine whether or not it should be tapped, but there are some conditions where it is unnecessary, *e.g.*, in small cysts, and others where it is undesirable, *e.g.*, dermoid cysts, and the pro-

liferating papillomatous forms, in these latter there may be active cells in the fluid contents, and the escape of these into the peritoneal cavity (and it is not always possible to prevent such escape) may result in infection of the peritoneum with these cells, and a new development of some form of epithelial growth may ensue

**Operation**—The patient is prepared in the usual way, the abdominal wall being purified and the vulva shaved, but unless there is some objectionable discharge, there is no need to douche or pack the vagina. The Trendelenburg position may be advisably adopted, as it enables the surgeon to get at the pedicle of the cyst more easily. An incision is made in the middle line above the pubis, and the anterior wall of the cyst is exposed. The finger or hand is swept round in order to ascertain whether or not there are any adhesions, if present, it may be possible to deal with them at this stage, but more usually it is easier to detach them later on. A Spencer Wells trocar is then thrust into the cyst, and as the fluid escapes, the relaxed wall is grasped by forceps and drawn up out of the incision so as to prevent the fluid getting into the peritoneal cavity. This end is not always attained, as the cyst wall is sometimes so soft and friable that it splits and bursts, and any attempt to grasp it with forceps leads to an increased rent in its substance. Under these circumstances the patient can either be rolled over on her side, and the contents scooped out by the hand, or possibly better, the incision is rapidly increased in length to a sufficient extent to allow the whole cyst to be lifted up out of the abdomen. Large secondary cysts may be opened by the trocar through the first main cyst, but in doing this care must be taken not to thrust the instrument through the posterior or lateral wall of the growth. The pedicle is now securely tied off, and any form of ligature which involves its transfixion will suffice. It is perhaps wise to divide the pedicle at such a distance from the ligature that the main ovarian vessels can be recognised on the stump, and an ordinary silk or cat-gut ligature can be separately applied to each of these, this plan will obviate any danger that might arise from the relaxation or slipping of the main ligature. The other ovary is then examined and dealt with according to circumstances. The peritoneal cavity is cleansed, and possibly when much of the cyst fluid has escaped it may be desirable to wash it out with salt solution, and the abdominal incision is then closed.

Broad ligament cysts (parovarian) often have no pedicle, and then must be enucleated after tapping. The layers of the broad ligament are divided in a suitable manner back and front, the supplying vessels are secured by ligature, and the cyst wall can usually be freed from its surroundings without difficulty. The opening in the broad ligament is subsequently stitched up, and probably no drainage will be required.

An ovarian cyst with a twisted pedicle is treated in the usual way after untwisting. An inflamed or suppurating cystoma must be dealt with according to circumstances, it may be possible to remove

it *en masse*, but incision and drainage without removal may have to be resorted to

An uncomplicated ovariectomy is one of the most successful major operations in surgery, and the death-rate is now phenomenally small. The presence of adhesions and other complications of course adds to the gravity, and increases the death-rate.

**Solid Tumours of the Ovary** are not very common, and consist of carcinoma, sarcoma, or myo-fibroma. *Carcinomata* are solid or cystic, they grow rapidly, and early involve surrounding parts, producing a generalized carcinomatous infection of the peritoneal cavity with ascites. Unless cystic, they are often of no great size. *Sarcomata* are usually more or less firm, and of the spindle-celled type, thereby closely simulating the *myo-fibromata*, in the former, however, the growth is more rapid, and ascites is more likely to be present. In all these cases extirpation should be practised, if possible.

**Salpingo-oophorectomy**, or removal of the ovary and its tube, is required in many conditions, *eg*, small solid or cystic tumours, hydro- or pyo-salpinx, and sometimes for dealing indirectly with inoperable carcinoma *mammæ*. The operation may be simple in the extreme, or one of the greatest difficulty if many adhesions are present. The Trendelenburg position is adopted, the usual mesial incision is made, the ovary is secured, and silk ligatures are carried through the broad ligament and tied above and below to secure the ovarian vessels. After removal of the tube and ovary, it is advisable to secure separately the chief vessels on the face of the stump. Adhesions are dealt with as may be required.

## CHAPTER XLIII

### AMPUTATIONS

By the term **Amputation** is meant the removal of some portion of the body which is injured or diseased to such a degree as to endanger the patient's life, or to preclude any hopes of its restoration to a normal, or even useful, condition. In this chapter we shall merely deal with the operation as applied to the extremities, amputations of organs such as the breast and penis having been described elsewhere. Necessary limitations of space force us to treat the subject somewhat briefly.

**Methods of Amputation**—Since the introduction of anesthesia, the methods employed for the purpose of removing limbs have been almost revolutionized, there is now no necessity to hurry through the operation, and hence many new proceedings, and these sometimes of a most complicated nature, have been

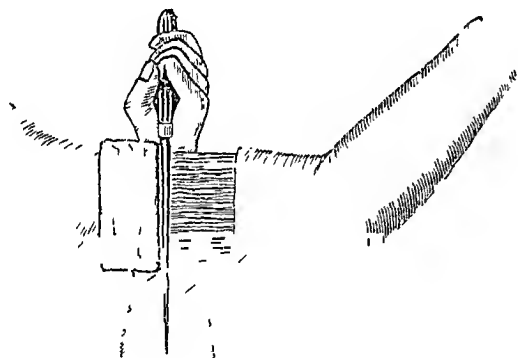


FIG 477 —CIRCULAR AMPUTATION FOR THE ARM, SHOWING FLAP OF SKIN TURNED BACK AND KNIFE APPLIED FOR DIVISION OF THE MUSCLES

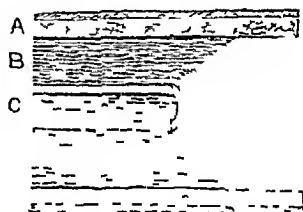


FIG 478 — SECTION OF PARTS AFTER CIRCULAR AMPUTATION

A, Skin and subcutaneous fat, B, muscles, C, bone

devised. They are in the main merely modifications of three cardinal operations, the circular, the racquet-shaped, and the flap.

The **Circular Amputation** (Fig 477), although formerly much employed, is now but little used, in it the skin and subcutaneous tissues are divided around the whole circumference of the limb by a circular sweep of the knife. These are then retracted or dissected back like a cuff, and the superficial muscles divided in a similar manner. The soft parts are again further retracted, and the deeper muscles divided, allowing the bone to be cleared and sawn through at a still higher level. The end of the bone is thus placed at the apex of a conical hollow (Fig 478), and can be completely covered over, the vessels, moreover, are divided transversely. The stump is not very shapely, and after a time, owing to

the shrinking of the soft parts, the cicatrix is likely to become attached to the bone. The arm is almost the only situation in which a pure circular operation is ever undertaken at the present day, but a modified form is still occasionally utilized elsewhere. Thus, one or two vertical incisions may be associated with the circular cut, in order to facilitate the removal of the bone at a higher level, as in disarticulation of the hip joint by Finckel's method (p. 1306).

The **Racquet-shaped Method** (Fig. 484, A and C) is very similar to the last-described modification of the circular. In it an oval incision is made around the limb with one end pointed, and if necessary prolonged upwards to form, as it were, the handle of the racquet. This method is useful for removing fingers and toes, and is also employed at the hip and shoulder joints.

A somewhat similar operation is known as the **Elliptical or Oval Method**. In

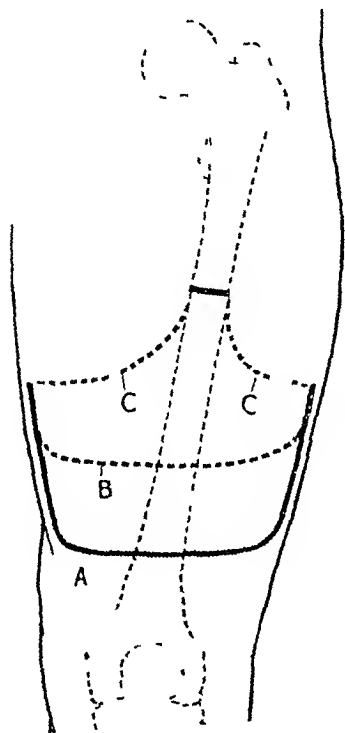


FIG. 479.—AMPUTATION OF THE THIGH BY LISTER'S FLAP AND CIRCULAR METHOD.

A indicates the anterior flap, B, the posterior, which is half the length of the anterior, C, the line of division of the muscles, which is performed by circular sweeps of the knife.

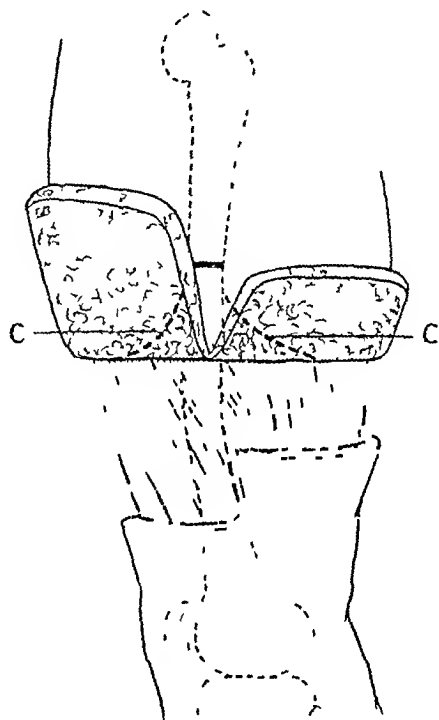


FIG. 480.—LATERAL VIEW OF THE SAME OPERATION WITH THE SKIN FLAPS DISSECTED BACK.

C again indicates the line of division of the muscles.

if an oval incision is made around the limb, the lower or distal portion is then dissected up so as to enable the amputation or disarticulation to be completed at a level a little below the proximal end. The free convex border of the flap is then turned over, and fitted into the concavity of the wound.

The **Flap Method** is that chiefly made use of at the present day in amputating through the shafts of the long bones. It was formerly performed by *transfixion* in order to save time, but the bulk of muscles included in the flaps, and the fact that the vessels and nerves are often sliced longitudinally, render this an undesirable proceeding. Hence it has been discarded, and the flaps are now usually marked out superficially, and then raised by *dissection*. As a rule, they



consist merely of skin, subcutaneous tissue and deep fascia, a little muscle being perhaps included towards the base

The best method of amputating in muscular parts, such as the thigh, is that known as the **Modified Flap and Circular** (Figs 479 and 480), which was originally suggested by Lord Lister. In this two rectangular flaps with the corners rounded off are raised on opposite sides of the limb, the length of the anterior being two-thirds of the diameter of the limb at the point at which it is proposed to divide the bone, and the posterior flap half the length of the anterior. These, consisting merely of skin and subcutaneous tissues, are dissected up, the muscles are then divided circularly, being retracted for another half diameter. The advantages of the flap and circular methods are thus combined. In cutting the flaps it is most essential that they should not taper, but should remain the same breadth throughout, the corners being merely rounded off.

### General Remarks on Amputations

Certain important details must always be attended to by the operator when selecting an amputation suitable for any particular case

1. A **Sufficient Covering** is necessary, in order to protect the end of the bone from injurious pressure. If the skin were not contractile, and if the muscles did not retract, it would suffice to provide two flaps, each equal to half the diameter of the limb at the point of section of the bone, but owing to the contractility and retraction of living tissues, it is essential to allow at least a diameter and a half, and sometimes two diameters, in non-muscular parts the former may suffice, but in fleshy parts, especially when amputating

low down in the thigh, where the range of muscular contraction is much greater, the latter. It is usually a matter of some significance whence the flaps are derived, thus, a *single flap*, e.g., a long anterior or posterior, is not to be recommended owing to the difficulty of maintaining its nutrition. *Equal flaps* are used in parts like the arm, where

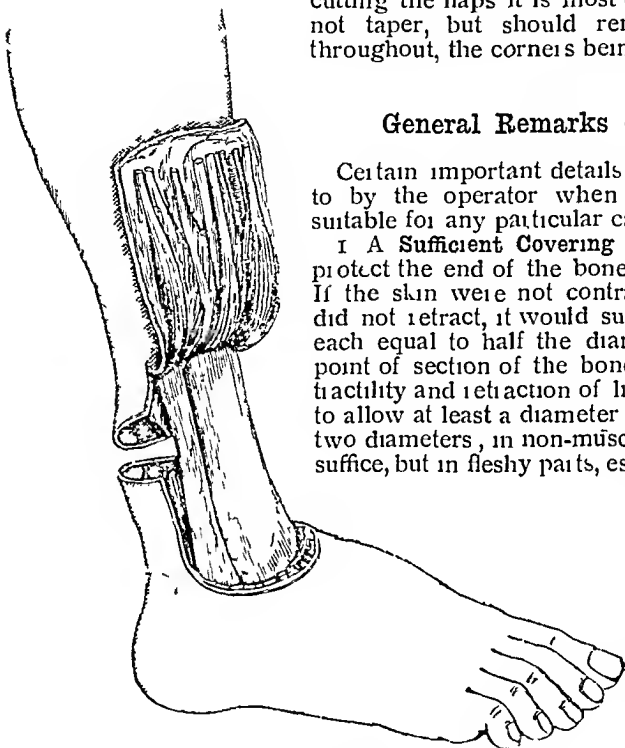


FIG 481.—TEALE'S AMPUTATION (TREVES' 'OPERATIVE SURGERY')

the end of the stump will not be exposed to pressure. Generally, however, the *anterior flap* is cut *longer than the posterior*, as in the case of the modified flap and circular, or sometimes *vice versa*, in the former, owing to the additional retraction of the muscles, a covering equal to two diameters of the limb is provided. *Teale's amputation* (Fig 481) consists in raising a long square anterior flap, equal in breadth and length to half the circumference of the limb at the point of section of the bone, and including everything down to the bone. The posterior flap is similar in nature to the anterior, but only a quarter of its length. The free end of the anterior flap is doubled over, and accurately stitched to the posterior (Fig 482). The advantages claimed for this operation are that the vessels are cut long, and thus the nutrition of the flaps is secured, whilst a covering nearly equal to two diameters of the limb is provided. The great objection to the method consists in the amount of the limb which has to be sacrificed on account of the length of the anterior flap, and hence it is rarely employed. Occasionally the covering is derived from the sides of the limb (amputation by *lateral flaps*)

2 The Cicatrix should be situated away from the end of the bone, especially in the lower extremity, where the weight of the body has to rest upon the stump

3 A Dependent Opening is desirable for purposes of drainage, and to ensure this the anterior flap is often made longer than the posterior. This, however, is not such an important matter since the introduction of antiseptic methods

4 All these objects should be attained with as little sacrifice of the limb as possible, since the higher the operation, the greater the shock to the patient

As to the operation itself, the greatest care must be taken to maintain Asepsis, since muscular and fascial planes have been freely opened, and possibly the medullary cavity of the bone exposed, the dangers of septic absorption under such circumstances are obvious. Hæmorrhage is pre-

vented by previous exsanguination of the limb by elevating it for two or three minutes, and then applying an elastic tourniquet. In the leg a piece of rubber tubing may be employed, Samway's tourniquet being perhaps the best. In the arm, however, paralytic symptoms, usually involving the musculo-spiral nerve, have followed the use of such appliances, especially when made of solid rubber, a flat elastic bandage carried several times around the limb, and secured by a knot or with a safety-pin, is all that is needed. Should the tourniquet have to be applied close to the area of operation, it must, of course, be first sterilized, it is also advisable to protect the skin over which it is placed by a few layers of gauze. After the limb has been removed, the main vessels are at once ligatured, both artery and vein being separately tied. It is well to isolate and draw them down for a little distance, so as to make sure that they have not been buttonholed. Any other vessels which can be seen are tied before the tourniquet is removed. An assistant should for a time be ready to control the main trunk after releasing it from the tourniquet. In some cases it may be impracticable or undesirable to apply a tourniquet, and then the main vessels may be temporarily controlled by digital compression at some suitable spot whilst the amputation is completed. Any bleeding points are rapidly secured by pressure forceps and subsequently tied, and the main trunks isolated, and clamped or ligatured before division.

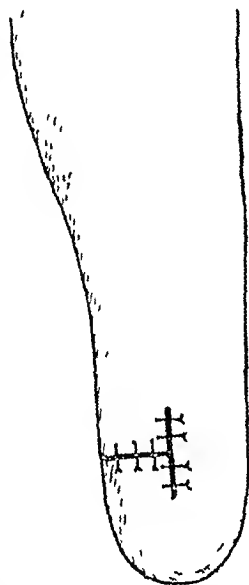


FIG 482 — TEALE'S AMPUTATION COMPLETED, TO SHOW THE METHOD OF SUTURING THE FLAPS

For special methods of controlling the hæmorrhage in amputation through the hip-joint, see p 1306

We have already drawn attention to the necessity of not tapering the flaps, but of cutting them square, the corners alone being rounded. In dissecting them up, the deep fascia should be included with the flap, and the blade of the knife always turned towards the part which is to be removed, so that the under surface of the flap, and with it the nutrient vessels, shall not be scored. Whilst dividing the muscles, the flaps must be carefully guarded by the hands of assistants. Before sawing the bone, it is recommended that the periosteum should be retracted for some distance, so as more efficiently to provide for its nutrition, this plan should certainly be adopted for the humerus and femur. Any irregular bony spicules left after sawing should be trimmed off with cutting pliers. Attention must next be directed to the main nerves and to any tendons which lie exposed in the wound, all such structures being cut short, the nerves as high as possible. It is always well to cover in the end of the bone by stitching the muscles together over it, and the little extra time expended in the introduction of these buried stitches will be well repaid in the increased shapeliness of the stump. The incision in the skin is usually closed by a continuous suture, and provision made for drainage from one of the angles of the incision. The dressing is applied in such a way as to draw the flaps down over the end of the bone, and a splint is generally necessary

in order to control the upper ends of the divided muscles and to keep them from painful spasmodic contractions

The chief **Complications** likely to arise in the subsequent course of the case are shock, reactionary hæmorrhage, and those which result from sepsis, these conditions and their treatment have been described elsewhere

In a **Healthy Stump** the end of the bone is rounded, and the medullary cavity closed by a layer of compact tissue. The divided muscles and tendons are either incorporated in the cicatrix, or gain fresh adhesions to the bones. The vessels are obliterated as far as the next patent branches, whilst the nerve ends usually become bulbous (Fig 104, p 373), but, if suitably shortened, do not adhere either to the end of the bone or to the cicatrix, and hence give rise to no trouble. A sufficient covering of non-adherent skin and subcutaneous tissue should form a pad for the protection of the bones.

**Affections of Stumps**—(a) *Necrosis* of the end of the bone is sometimes the result of carelessness on the part of assistants, who can readily denude it of its periosteum by rough sponging, etc., it rarely follows if the periosteum has been first retracted before the bone is divided, and practically never apart from sepsis. A small annular sequestrum is usually all that separates, but should the inflammation spread up the medullary cavity (*septic osteomyelitis*), a more extensive destruction of bone tissue follows (for symptoms and treatment of which see p 561). (b) *Sloughing of the ends of the flaps* occurs in debilitated individuals,

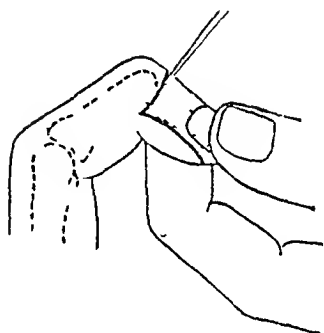


FIG 483—INCISIONS FOR AMPUTATION OF TERMINAL PHALANX OF FINGER

especially if thin skin flaps have been employed, or if their nutrition has been impaired by trauma, or if unhealthy tissue has been incorporated in their substance by amputating too close to the seat of disease or injury. The process is usually limited in extent, and rarely calls for treatment other than keeping the part dry and aseptic, the slough being then slowly absorbed, if sepsis is present, the consequences may be very serious, even necessitating re-amputation at a higher level. (c) A *conical stump* results either from the flaps being cut too short, or from the parts shrinking as a result of septic inflammation, or in young people from continued growth of the upper epiphyseal cartilage of the divided bone. In bad cases the bone may even project through the integument, and necrose, re-amputation is the only treatment. (d) A *painful stump* is usually due to the adhesion of a bulbous nerve end to the

cicatrix or bone, so that it is dragged upon at each movement of the limb. The pain is of a severe neuralgic nature, and is treated by excising the bulb, or re-amputation. (e) A *spasmodic stump* sometimes occurs, being due either to irritation of the enlarged nerve-ends, or to some central cause. In the former instance, excision of the bulbs or re-amputation will cure the case, in the latter, the trouble will persist in spite of treatment, affecting fresh groups of muscles after re-amputation.

### Special Amputations

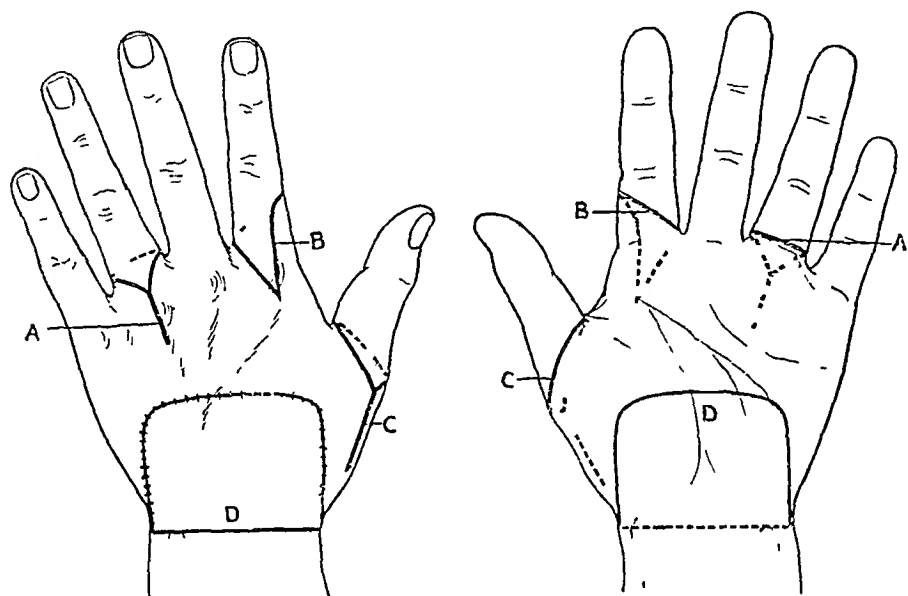
**Amputation of the Fingers** is frequently required after machine accidents and similar injuries, or in necrosis following a whitlow. In these cases it is often impossible to follow any regular routine, the flaps being obtained from any portion of sound tissue present. The following, however, are the chief plans adopted.

**Amputation of the Terminal Phalanx** is usually conducted by opening the joint on the dorsal aspect, and cutting a palmar flap from the pulp of the finger (Fig 483).

No useful result follows amputation through the first inter-phalangeal articulation, since the portion left is practically fixed and useless, no tendons being

inserted to govern it. An operation which is sometimes advantageous consists in amputating through the middle of the second phalanx, so as to leave the insertion of the flexor sublimis tendon, the flaps for such an operation being derived from any part of the finger, and the bone divided by cutting pliers.

**Removal of a finger at the Metacarpo-phalangeal Joint** is an operation frequently necessary. It is best conducted by means of a racquet-shaped incision (Fig 484, A), which starts over the knuckle, extends between it and the next finger, curves round to the palmar aspect so as to be placed a little below the crease in the skin at the root of the finger (Fig 485, A), and returns in the same way to the back of the knuckle. This incision can be made with one sweep of the knife, but there is no real advantage in such a procedure. The articulation is then opened from behind, the structures on either side are successively



FIGS 484 AND 485 —DORSAL AND PALMAR VIEWS OF HAND WITH INCISIONS FOR VARIOUS AMPUTATIONS

A, incision for amputation of finger by racquet method, B, Farabœuf's method of amputation, as applied for index-finger, C, racquet-shaped incision for disarticulation of thumb at carpo-metacarpal joint, D, amputation through the wrist by a long palmar flap. In all of these the continuous black lines indicate the portions of the incisions visible from the dorsal or palmar aspects respectively, the interrupted lines, the portions that are hidden.

divided, making them tense by rotation of the finger, and the flexor tendons finally cut across. Bleeding points (usually one on each side) are secured, and the wound closed.

The question of removing the head of the metacarpal bone is one which must be decided by the occupation of the patient, if he is a working man, or needs strength of hand, it should be left, as its removal always causes weakness. In ladies and those where smallness and elegance of the hand are required rather than strength, it can be taken away by slightly prolonging the incision upwards, clearing the bone on either side, and applying cutting pliers. The gap between the adjoining fingers can in this way be almost obliterated. It is especially advisable to do this in the case of the index-finger, since the head of the second metacarpal bone forms an unsightly projection, and is very exposed to injury. For this finger, Farabœuf's method (Figs 484 B, and 485, B) is often used.

Occasionally the four fingers and their attached metacarpal bones have to be removed *en bloc*. Short equal flaps may then be cut from the front and back of the hand, and the disarticulation effected. The stump that remains, although consisting merely of the carpus and thumb is very serviceable.

**Amputation of the Thumb** should never be undertaken unless absolutely necessary, since its removal seriously impairs the functional utility of the hand, as large a portion must be saved as practicable, so as to assist the patient in grasping. The phalanges may be removed by any method which enables the bone to be covered with the least possible sacrifice.

When it is also necessary to take away the metacarpal bone, one of the two following plans should be adopted.

1 *The racquet method* (Figs 484, C, and 485, C). In this an incision commences in the intertendinous hollow known as the *tabatiere*, and extends along the dorsum of the thumb to the head of the metacarpal bone, the oval portion sweeping round it at the level of the web when the thumb is abducted, and on the palmar aspect corresponding to the oblique crease at its root. The remainder

of the operation resembles that for removal of a finger. Care must be taken not to wound the trunk of the radial artery as it passes through the base of the interosseous space, the blade of the knife is therefore kept closely applied to the bone.

2 *By a palmar flap*. In this the knife is first carried across the dorsal aspect of the thumb, from the centre of the web between it and the index-finger, to a point on the palmar surface of the wrist just above the thenar eminence. The knife is then rotated so that its cutting-edge looks outwards, and inserted deeply through the ball of the thumb, transfixing it, so as to emerge at the same spot in the centre of the web as that at which the incision commenced. A muscular flap with a well-rounded border is readily fashioned by cutting outwards. The remaining soft parts are then divided, and disarticulation completed by opening the joint. It is a prettier and more showy operation than the former, but otherwise has no advantages.

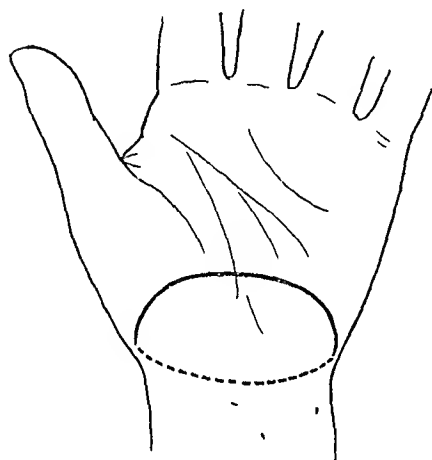


FIG 486 —AMPUTATION OF THE WRIST  
BY ELLIPTICAL METHOD

The dark line indicates the palmar flap,  
the dotted line the dorsal incision

**Amputation through the Wrist-Joint** is seldom performed except for injuries, and then the flaps must be derived as best they can from healthy tissues. Three chief methods are, however, described. (a) In the *elliptical* (Fig 486), the incision takes the form of an ellipse, the highest point being on the dorsum  $\frac{1}{2}$  inch below the level of the wrist-joint, and the lowest in the centre of the palm 2 inches below the former. On the ulnar side, the incision passes between the pisiform bone and the base of the fifth metacarpal, whilst on the radial side it crosses the carpo metacarpal articulation. After dividing the cellular tissue, and dissecting up the palmar flap, the joint is opened from the posterior aspect, and the disarticulation completed. The convex end of the palmar flap is fitted into the concavity of the dorsum, and the cicatrix thus forms a curved line on the back of the stump. (b) A *long palmar flap* (Fig 485, D) is sometimes utilized, extending from just below either styloid process down to about the middle of the metacarpal bones, the sides of this flap being parallel to each other. The dorsal incision crosses the carpus horizontally between the two extremities of the former wound (Fig 484, D). The palmar flap is then dissected up so as to include only skin and subcutaneous tissue, with perhaps a little muscular tissue from the thenar and hypothenar eminences. The wrist-joint is opened from the

dorsum, and the amputation completed by the division of the flexor tendons (c) In a few cases, amputation by an *external flap* may be desirable (Dubreuil's method) The incision commences at the junction of the middle and outer thirds of the back of the wrist, reaches down to the head of the metacarpal bone of the thumb, terminating at a point in the palm immediately opposite its commencement This flap is dissected up, and should contain a certain amount of muscular substance from the thenar eminence The skin and subcutaneous tissues on the ulnar aspect are now divided by a circular sweep of the knife around the inner side of the limb Disarticulation follows, and the external flap is carried inwards, and sutured so as to close the wound

**Amputation through the Forearm** is usually conducted by means of a flap operation, the flaps being either equal in length or one a little longer than the other The muscles are divided circularly, and the bones should be thoroughly cleared before division

**Disarticulation at the Elbow-joint** is an operation very rarely seen, and is either undertaken by the elliptical method or with a long anterior flap

**Amputation through the Arm** may be carried out by any of the methods described, *e.g.*, the flap, circular, or modified flap and circular, the choice in any particular instance being determined by the requirements of the case

**Disarticulation at the Shoulder joint**—Three chief methods are practised for the performance of this operation, viz, Spence's, Larrey's, or that by means of an external or deltoid flap In all, the third part of the subclavian artery may be controlled by digital compression, the surgeon endeavouring to leave the division of the main vessels until the last stage of the proceedings, but it is perhaps better to clamp all the smaller vessels as soon as they are cut, and to isolate and tie the main trunks before their division



FIG 487 —SPENCE'S AMPUTATION AT THE SHOULDER BY ANTERIOR RACQUET (TREVES' 'OPERATIVE SURGERY')

(a) *Spence's operation* (Fig 487) —A preliminary incision similar to that for excision of the shoulder is first made, extending downwards and outwards through the fibres of the deltoid, from a point midway between the coracoid and acromion processes This passes directly down to the bone, and, if necessary, the joint is at once opened and examined prior to any further steps being taken The surgeon, standing on the outer side of the limb, then carries his knife from the lower part of the incision downwards and inwards across the axillary folds around the limb to the point from which it first started, thus making the incision racquet-shaped The skin is first dissected up all round for an inch or so, and then the muscles on the inner side, the deltoid in part, the pectoralis major, the coraco brachialis and biceps, are divided on the slant, thereby exposing the main vessels and nerves The vessels may now be secured and divided, and the nerves isolated, pulled down and cut short, or they may be left intact for a time The soft structures on the outer side of the vertical incision are next separated from the bone, and then the outer half of the capsule, together with the muscles inserted into the greater tuberosity of the humerus, and the long tendon of the biceps, are divided The inner half of the capsule and the subscapularis are then cut through so as to free the head of the bone By retracting the external flap and protruding the head from its socket, the posterior part of the capsule can be severed, and then the knife, travelling downwards between the humerus and the axillary vessels, is made to cut its way out, thus completing the disarticulation, the vessels and nerves, if not already dealt with, being divided as the last step in the proceeding If the knife is kept close to the bone, the trunk of the posterior circumflex artery is not interfered with

(b) *Larrey's operation* (Fig 488) is very similar to the above, except that the vertical incision is made on the outer aspect of the joint, reaching downwards from the prominence of the acromion for a distance of about 6 inches, the oval

portion starting from its centre, and being directed obliquely downwards and inwards. The tissues are reflected on either side of the humerus, the joint is opened by a transverse cut over the great tuberosity, which also divides the muscles inserted into it. The knife is finally carried down on the inner side of the humerus so as to sever the vessels last, if considered desirable.

(c) Amputation by the external or *deltoid* flap is but little practised at the present time. The flap is either cut by transfixion, or dissected up. It is U-shaped, its base extending from the coracoid process in front to the root of the acromion behind. A skin incision is now made across the inner aspect of the limb, joining the ends of the former incision, and extending about 2 inches below the axilla. Disarticulation is then carried out in the same way as in the previous methods.

Occasionally it is necessary to remove the whole of the upper limb together with the scapula and outer third of the clavicle, for new growths, usually of a sarcomatous nature, or for injury. This so-called **Interscapulo thoracic Amputation** is best performed according to Berger's method. An incision is made along the clavicle, and the middle portion of this bone is then removed so as to enable the surgeon to divide between ligatures the subclavian artery and vein on a level

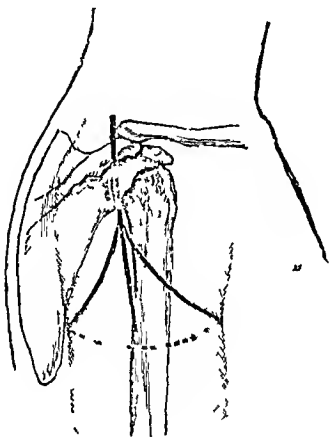


FIG 488 —LARREY'S AMPUTATION THROUGH THE SHOULDER-JOINT BY EXTERNAL RACQUET (TREVES' 'OPERATIVE SURGERY')

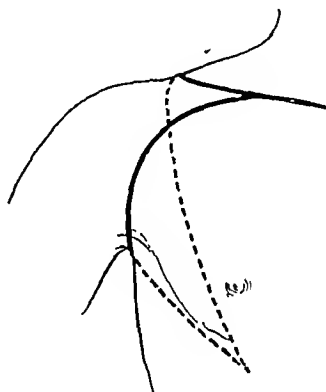


FIG 489 —INCISIONS FOR THE INTERSCAPULO THORACIC AMPUTATION

with the lower border of the first rib. The anterior flap is then formed by an incision (Fig 489) reaching from the centre of the former and extending downwards and outwards over the shoulder, across the anterior fold of the axilla, and as far as the lower angle of the scapula. The pectorales major and minor are divided along this line, thereby exposing the brachial plexus, the constituent nerves of which are severed on a level with the section of the vessels. The axillary space can now be opened up along the outer surface of the serratus magnus. The limb is then rotated inwards and adducted across the trunk, and the patient drawn well to the edge of the table so as to enable the posterior incision, which unites the outer ends of the two former, to be made. The flap thus marked out is dissected up, and the different muscles retaining the scapula in connection with the body are divided one after the other, including the trapezius, omohyoid, levator anguli scapulae, rhomboids, and serratus magnus. These may be incised as near to the bone as is thought compatible with the total removal of the growth. Any remaining fibres are cut across, and the limb is thus detached. In cases of new growth there may be a large number of vessels, both arteries and veins requiring ligature, but in a healthy limb removed for injury, none but the posterior scapular and supra scapular will give any

trouble Naturally, such an operation is accompanied by some amount of shock, but the results hitherto obtained have been very gratifying

## Amputations of the Lower Extremity

**Amputation of the Toes** at the metatarsophalangeal articulations is precisely similar to the analogous operation on the fingers It must be remembered that the joint lies as far behind the web as the apex of the toe is in front of it, and hence the incision must start farther back than might be expected

For the removal of the great toe from the metatarsal bone, *Farabœuf's operation* is the best The incision (Fig 490) commences over the head of the latter bone, and well to the inner side of the extensor tendon, it extends downwards nearly as far as the interphalangeal articulation, and then crosses the plantar surface of the toe so as to reach the centre of the web between it and the second toe, thence

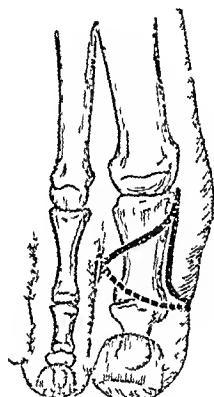


FIG 490 —FARABŒUF'S AMPUTATION OF THE GREAT TOE (TREVES' 'OPERATIVE SURGERY')



FIG 491 —INCISIONS FOR LISFRANC'S AMPUTATION (TREVES' 'OPERATIVE SURGERY')

the knife is carried straight back to the commencement of the incision These cuts are deepened, the tendons divided, the joint opened, and the toe removed It will then be found that an internal flap remains, which can be brought across the head of the metatarsal bone, and covers it in so that the L-shaped cicatrix is not exposed to pressure

Amputation of the great toe at the tarso-metatarsal articulation is conducted either by a racquet-shaped incision, or by dissecting up a flap from the inner side It is a bad operation, leaving a terribly mutilated foot, and should, if possible, never be undertaken

Amputation of the foot at the **Tarso-metatarsal Articulation** is performed either by Lisfranc's or Hey's operation

*Lisfranc's amputation* (Fig 491) consists really of a disarticulation, no bone being sawn across The patient lies on the back with the foot elevated, and extending beyond the end of the table On the right foot a slightly convex dorsal incision extending down to the bones is made from the tip of the fifth



metatarsal bone on the outer side to the base of the first on the inner. The plantar flap is then marked out, reaching from the terminations of the former incision forwards as far as the roots of the toes, and being necessarily longer on the inner than the outside side. On the left foot the incisions are made in the opposite direction. This latter flap is dissected up, the toes being fully extended by an assistant, only the skin and subcutaneous tissues are raised for the first inch, but further back all the structures in the sole of the foot are included. The appearance of the peroneus longus tendon will indicate that the dissection has been carried back far enough. Disarticulation is now performed from the dorsal aspect, the line of the joints (Fig 492) being kept in mind. The knife is entered behind the spur of the fifth metatarsal bone, and is at first directed forwards and inwards towards the head of the first metatarsal bone. The line of the articulation

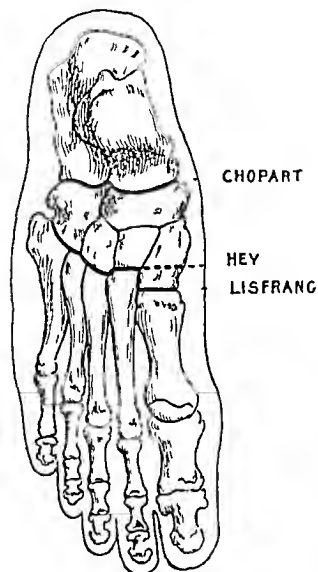


FIG 492 — SKELETON AND OUTLINE OF FOOT SHOWING LEVEL OF VARIOUS AMPUTATIONS

is then followed as far as the base of the second metatarsal, which projects backwards between the internal and external cuneiform bones. The joint between the first metatarsal and the internal cuneiform is now opened transversely on the inner side, and the dorsal ligament between the second metatarsal and the middle cuneiform divided. The strong interosseous ligament passing between the internal cuneiform and the base of the second metatarsal is next severed by inserting the point of a knife downwards between the first and the second metatarsal bones, and cutting backwards towards the ankle, elevating the handle of the knife in order to do so. By grasping the toes in the left hand, and forcibly depressing them, the remaining ligaments on the dorsal aspect are divided, and the disarticulation can then be completed.

The plantar flap is sometimes formed as the first stage of the operation, having merely been mapped out in the first instance. In such a case the dorsal incision is first made, the metatarsus disarticulated, and the plantar flap cut from within outwards.

*Hey's operation* is essentially similar to the above, with the exception that the projection of the internal cuneiform is sawn across (Fig 492), leaving a more even surface of bone. It is certainly to be preferred to a simple disarticulation. *Skely* advised that the three outer joints should be opened as above, and that then the saw should be applied

so as to leave in its mortice the base of the second metatarsal, whilst the projection of the internal cuneiform is removed.

**Amputation at the Mid-tarsal Joint** (*Chopart's amputation*, Fig 492) is conducted in a very similar manner to *Lisfranc's*. A plantar flap with convex end is marked out, reaching on the inner side of the foot from a point immediately behind the tubercle of the scaphoid forwards to within 1 inch of the root of the toes, and terminating on the outer side on a level with the calcaneo-cuboid articulation, i.e., midway between an external malleolus and the spur of the fifth metatarsal. It should be 1 inch longer on the inner than on the outer side. This plantar flap is first dissected up, including everything down to the bones, and then a dorsal incision is made with a slightly convex border. The joints between the astragalus and scaphoid on the inner side, and between the os calcis and cuboid on the outer, are opened from above. Disarticulation is completed by a few touches of the knife, and after all hæmorrhage has been arrested, the plantar flap is drawn up, and united by sutures to the dorsal. Some surgeons prefer to fashion the plantar flap after opening the joints from the dorsum.

*Chopart's amputation* is not, on the whole, a very satisfactory proceeding,

since it consists in the removal of the anterior segment of the arch of the foot, the posterior half being left without support. The natural result of this is that

upon the anterior as balanced muscular traction, and hence attempts to prevent it were made by dividing the tendo

Achillis, or by stitching the extensor tendons to the under surface of the os calcis. Seeing, however, that the trouble is mainly mechanical, and hence unavoidable, it would perhaps be wiser to avoid the operation entirely, substituting for it a subastragaloid amputation, or modifying it by removing the astragalus after the foot has been taken away. Tripiet's amputation has also been utilized to prevent such displacement, in it an oblique external racquet is made, reaching backwards to the anterior border of the tendo Achillis, disarticulation follows at the mid-tarsal joint, and then the os calcis is sawn across horizontally on a level with the sustentaculum tali, so as to leave a broad base of support, which is not so likely to become tilted forwards. It is but fair to say, however, that in not a few cases of Chopart's amputation an excellent stump remains without any of these inconveniences.

A still better modification,\* where practicable, is to remove the foot on a slightly anterior plane, i.e., to leave the scaphoid on the inner side, and to divide the cuboid on a level with its anterior border with a saw. The skin incisions can be made as for a Chopart. The stump left is longer, and therefore controlled more easily, whilst the attachment of the tibialis posticus is maintained, and it is easy to give the peroneus longus an insertion, so that the lateral movements of the foot are in great part preserved.

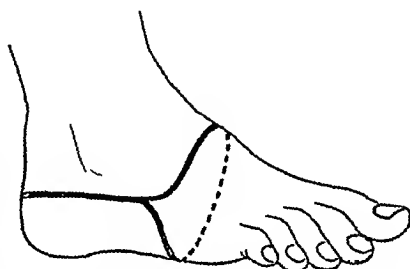


FIG. 493.—RACQUET INCISION FOR SUBASTRAGALOID AMPUTATION

Amputation of the foot is occasionally possible in cases of astragalus remains uninjured. The best plan to adopt is that known as *Maurice Perrin's oval operation*. A racquet-shaped incision (Fig. 493) is made, commencing at the insertion of the tendo Achillis, and extending along the outer border of the foot to a point immediately behind and a little above the spur of the fifth metatarsal, from which it sweeps over the dorsum, along the instep, and after crossing the sole returns to the same spot. The dorsal part of the flap is then dissected up, the astragalo-scapoid joint opened, the tendo Achillis divided and by twisting the foot inwards the joints between the astragalus and os calcis can be entered, and the interosseous ligament severed. By still further inverting the foot until it assumes a position of extreme varus, the structures on the inner side of the os calcis can be detached, and by continuing the same torsion, the inner surface of the bone is finally cleared, the dorsal aspect of the foot looking downwards. When the root has been removed, the tendons and nerves cut short, and the wound, which is secured by sutures. A very firm basis of support is provided by this operation, and the stump is covered by the skin of the heel, which is accustomed to pressure.

**Amputation of the Foot—Same** is of a disarticulation at the ankle-joint, together with removal of the astragalus and the articular surface of the tibia. The patient lies on the back with the leg well elevated and projecting over the end of the table, the surgeon standing either below or a little to the right of the patient. Having exsanguinated the limb, the operation is on the right foot, commenced by making an incision from the tip of the heel up to the point of the internal malleolus (Fig. 494). On the left side the incision is made in the

opposite direction. For this purpose a short-handled strong bladed knife should be employed (an ankle-knife). The inc otherwise a bucket-shaped heel flap is for

The knife is carried down to the bone at the first cut, and the surgeon then proceeds to dissect up the heel flap, thus marked out by inserting his thumb into the wound, and partly peeling, partly cutting, the soft tissues from the back of the os calcis. This is sometimes a tedious and tiring proceeding, since it is most important to keep close to the bone for fear of dividing the nutrient vessels of the flap (external and internal calcaneum). The dorsal incision (A') is then made, uniting the ends of the former wound, and carried slightly forwards so as to mark out a short convex flap. This is dissected up, and the ankle joint opened, the line of the articulation being placed 1 inch above the tip of the internal malleolus. By division of the lateral and posterior ligaments, of the tendo Achillis, and of the few remaining fibrous connections along the top of the os calcis the foot is removed. The lower ends of the tibia and fibula are then cleared and sawn off (S), the ends of the dorsal flap being meanwhile held out

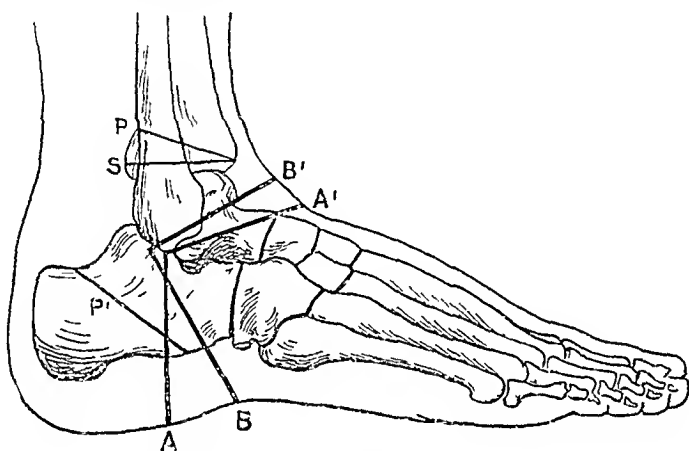


FIG 494 —LINES OF INCISION IN BONES AND SOFT PARTS IN SYME'S AND PIROGOFF'S AMPUTATIONS

A, A', Incisions for Syme's amputation, B, B', incisions for Pirogoff's amputation (these should really start from the same point as in Syme's operation, viz, the tip of the external malleolus, but to avoid confusion they have been placed a little behind it), S, section of tibia and fibula in Syme's amputation, P, section of tibia and fibula in Pirogoff's amputation, P', line of section of the os calcis in Pirogoff's amputation

of hum's way. The main vessels are tied, as also any other bleeding-points, the tendons and chief nerves are drawn down and cut short, and the wound closed by sutures, provision being made for drainage through one of the angles.

A much quicker and prettier method of performing this operation consists in opening the joint, and disarticulating immediately after the incisions have been made whilst the os calcis is subsequently dissected out of the heel flap from above, keeping the knife close to the bone.

Syme's amputation gives excellent results with only slight shortening, and the patient is able to walk on skin which is already accustomed to pressure. It is specially useful where amputation is required for tarsal disease, inasmuch as it is then rarely safe to undertake any of the partial or more conservative methods of operating.

Pirogoff's operation is one in which the posterior portion of the os calcis is sawn off, and applied to the under surface of the previously sawn ends of the tibia and fibula. The operation here described is not strictly that of Pirogoff, but rather

the modification placed as for § incision is made extending from the same points, viz, between the tip of the external malleolus and a point  $\frac{3}{4}$  inch below and behind the inner malleolus, but ~~obliquely for wards~~ <sup>wards it is carried</sup> (Fig. 495) and the dorsal incision is then made, being ~~completed~~ <sup>es to the plantar</sup> (B). The ankle-joint is opened from above, completed, the structures to the side of and behind the joint are then divided, so that a saw can be applied to the exposed surface of the os calcis, and the bone cut in a direction more or less parallel to that of the plantar flap (P<sup>1</sup>). The lower ends of the tibia and fibula are now cleared, and the malleolus and articular surface sawn off obliquely, the saw-cut being as nearly as ~~made through~~ <sup>to that</sup> made through ~~The~~ <sup>object of this obliquity is to enable</sup> the object of this obliquity is to enable the sawn end of the posterior part of the os calcis to be brought into apposition with the similarly treated ends of the bones of the leg, and wired to them without any traction on the tendo Achillis. By this operation a somewhat longer stump is obtained than in Syme's and the patient is able to walk on the posterior part of the os calcis instead of on the sawn ends of the tibia and fibula. The operation is more useful in cases of injury than for disease.

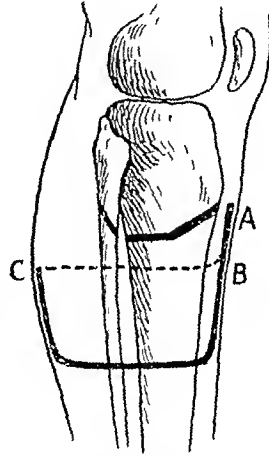


FIG 495.—FARABÆUF'S AMPUTATION AT THE SITE OF ELECTION, A HAND'S-BREADTH BELOW THE KNEE

The continuous line, A, B, C, indicates the shape of the large external flap, the dotted line, B, C, the incision on the inner side of the limb. The direction in which the bones are sawn is also shown

**Amputations of the Leg** may be undertaken either immediately above the malleoli (supramalleolar) or in the middle third, or a hand's-breadth below the knee (site of election). In the two former positions almost any operation may be practised according to the needs of the case, but perhaps the most satisfactory is that by means of equal lateral flaps, each of which is equal in length to one diameter of the limb, and consists below of skin, fat, and deep fascia, but for the upper half the muscles are also included (Fig 496, 1). In dividing the bones, care must be taken not to leave a sharp projecting edge on the front of the tibia. This is best prevented by partially sawing through the bone in an oblique direction from above downwards and when this has reached a little beyond its centre, the saw is withdrawn, and a horizontal section made, cutting across the oblique incision in such a way as to remove a wedge of bone from the front of the tibia, which thus becomes suitably bevelled. The fibula should always be divided before completing the section of the tibia.

In the lower third of the leg, Teale's amputation (Fig 481) is sometimes recommended, and gives good results.

**Amputation of the Leg at the Site of Election** may be performed either by the modified flap and circular operation, or by a large external flap (*Farabæuf's operation*). In the latter, the external flap (Fig 495, A, C), which is U-shaped, is first marked out with the knife, extending  $1\frac{1}{2}$  inches higher in front than behind, and its length being equal to the diameter of the limb at the point at which the bones are to be divided. The incision on the inner side is then made, extending directly across the limb from a point  $1\frac{1}{2}$  inches below the upper end of the anterior horn of the former incision to its posterior extremity (B, C). The

external flap is dissected up, commencing anteriorly, the fingers and knife being inserted between the tibia and the fibula, all the soft parts down to the bone and interosseous membrane are divided obliquely. The anterior tibial artery is cut long, and care must be taken not to free the flap from the interosseous membrane too high, for fear of injuring the trunk of this vessel as it passes between the bones, an accident which would seriously imperil the vitality of this huge and fleshy mass. The tissues on the inner side of the limb are now divided, either by transfixion or circular division. The interosseous membrane and bones are freed, and the saw applied according to the method already described.

Disarticulation at the Knee-joint is a very useful and valuable proceeding. The methods chiefly employed are as follows: (1) *Stephen Smith's operation*, or amputation by equal lateral flaps. The incisions extend from a point immediately

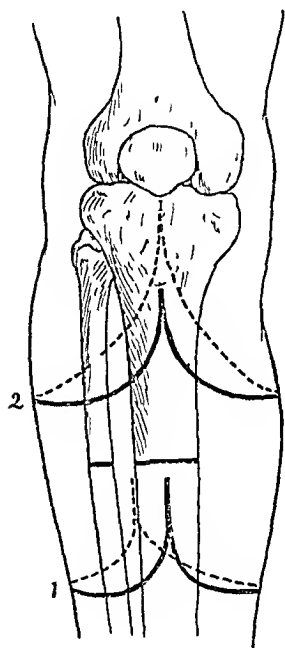


FIG 496—1 AMPUTATION OF THE LEG BY LATERAL FLAPS 2 STEPHEN SMITH'S AMPUTATION THROUGH THE KNEE-JOINT

below the tuberosity of the tibia backwards in a semilunar fashion, to terminate in the middle line behind on a level with the joint (Fig 496, 2). The incision on the inner side should reach a little lower than that on the outer, in order to ensure sufficient covering for the inner condyle, which is always larger than the outer. The flaps are dissected up all round, including the subcutaneous and deep fascia, being turned back in front like a collar, so as to enable the surgeon to reach and divide the insertion of the ligamentum patellæ. The knife is now carried along the upper margin of the tibia, separating the attachments of the semilunar cartilages to the bones by dividing the coronary ligaments. The surrounding muscles and tendons are cut through at the same level, together with the crucial ligaments, and the leg is finally separated by boldly sweeping the knife through the soft parts at the back of the joint, the flaps being well retracted. The popliteal vessels are secured, and the flaps drawn together in the median line. When union has occurred, the cicatrix is drawn up behind into the intercondylar notch so that an excellent hooded covering is provided for the lower end of the femur. The chief objection to the operation is that the upper part of the synovial membrane of the joint remains intact, and may become distended by a serous effusion through the irritation produced by wearing an artificial limb. (ii) Amputation can be undertaken

by a long anterior flap, the patella being left *in situ* or removed, according to circumstances. A short posterior flap is also formed and dissected up, so as to enable the muscles and vessels to be divided transversely.

**Supracondylar Amputation of the Thigh** is an operation often requisite in order to deal with disease or injury involving the knee-joint. (a) *Curden's amputation*, slightly modified, is one excellently adapted to this purpose. An anterior flap (Fig 497, A) is fashioned from the most prominent point of one condyle to that of the other, the incision crossing the mid-line in front halfway between the patella and the tibial tubercle. This flap is dissected up in front of the patella as far as its upper border. A short posterior flap is then dissected up (Curden made his posterior incision horizontal). A transverse cut above the patella divides the knee-joint open, and after flexing the limb the lateral and crucial ligaments are divided. The hamstring muscles, etc., are saved by cutting from without inwards, and a few touches of the knife will then serve to disarticulate.

The muscles are retracted, and the femur divided a little above the condyles (b) *Lister's modification* (Fig 497, B) consists in making a transverse incision across the front of the limb on a level with the upper border of the tubercle of the tibia. The horns of this incision are joined posteriorly by carrying the knife downwards at an angle of forty-five degrees to the axis of the leg. This flap is dissected up, and the whole of the integuments and subcutaneous tissues are freed and retracted like a cuff, so as to enable the muscles to be divided circularly just above the patella. The saw is then applied and the bone removed. By this means the covering of the end of the bone is taken more from the back than from the front of the limb. (c) *Grilli's operation* (Fig 498) is thus performed. A large anterior flap similar to that used in Carden's operation is dissected up, including the patella, and a shorter posterior flap is then fashioned. The soft parts are divided by a circular cut of the knife, and the femur sawn across about the level of the adductor tubercle. The cartilaginous surface of the patella is then removed with the saw, and the remaining portion of the bone secured by a silver wire to the divided end of the femur. Considerable difficulty may be experienced in

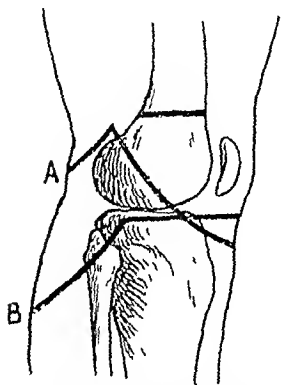


FIG 497 — INCISIONS FOR SUPRA-CONDYLOID AMPUTATION OF THE THIGH

A, Carden's operation, B, Lister's modification of the same

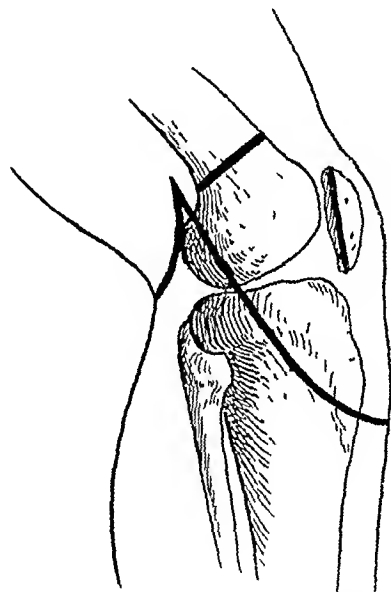


FIG 498 — STOKES' GRILLI AMPUTATION, SHOWING INCISION IN THE SOFT PARTS AND THE LINES OF SECTION IN THE FEMUR AND PATELLA

keeping the patella in accurate apposition, and to obviate this Stokes recommended division of the femur at a slightly higher level—*i.e.*, above rather than through the condyles. (d) Amputation by a *long posterior flap* is sometimes required in cases where the tissues in front of the limb have become disorganized from disease of the joint, or when cicatrices produced by a previous excision are present. The posterior flap is first marked out and dissected up, including merely the skin and subcutaneous tissues. A transverse incision is made across the limb above the cicatrices or sinuses, the bone sawn just above the site of the preceding excision, and the posterior muscles and vessels divided circularly. A very good stump usually results.

**Amputation of the Thigh** may be conducted by any of the general methods already described, but Lister's operation, modified flap and circular (Figs 479 and 480) is perhaps the best.

**Amputation through the Hip joint**—Disarticulation at the hip-joint is always an operation of the greatest gravity, and every precaution should be taken to

minimize the immediate risks by preventing hemorrhage and lessening shock. No part of the body should be unnecessarily exposed, whilst the head is kept low, and although the operation must not be hurried over, no time is wasted.

Perhaps the best way of preventing hemorrhage is to secure the main vessels before dividing them, and then to take up each bleeding point as it appears, the limb can thus be removed with the loss of merely a few ounces of blood. Other plans which have been suggested are (a) Lister's aortic tourniquet, which, however, is not to be recommended, partly because it is difficult to apply to stout or muscular individuals, and in any case it is very liable to slip. (b) Davy's rectal lever for compression of the common iliac artery consists of a rod of ebony, vulcanite, or metal, which is inserted into the rectum, and directed so as to compress the artery against the brim of the pelvis. It is dangerous in application and not always efficient. (c) An elastic tourniquet may be applied either around the upper part of the thigh to control the lower end of the external iliac, or around the body in such a way as to compress the abdominal aorta. For the latter purpose a pin cushion or pad is placed on the abdomen over the aorta, and behind the back a board projecting a few inches on each side of the trunk, and with two notches cut at either end. The elastic rod is passed over the cushion, and around the notches at the end of the board in a figure-of-8 fashion, sufficient tension being employed to force the cushion down on the aorta, and thus control the circulation through it. This method, which was also suggested by Lord Lister, is certainly efficient, though somewhat cumbersome. (d) More recently Wyeth, of New York, has introduced a method of preventing hemorrhage by applying a rubber tourniquet close to the pelvic brim, which is prevented from slipping by inserting long needles immediately below it. The limb is first exsanguinated by elevation, or possibly by the use of an Esmarch's bandage. Two long steel needles, 10 inches in length and  $\frac{3}{16}$  inch in thickness, are then inserted, one on the outer side of the thigh and one on the inner. The former is introduced  $\frac{1}{2}$  inch below the anterior superior spine of the ilium, and slightly to the inner side of this prominence, and is made to traverse superficially for about 3 inches the muscles and fascia on the outer side of the hip, emerging on a level with the point of entrance. The point of the second needle is thrust through the skin and tendon of origin of the adductor longus muscle  $\frac{1}{2}$  inch below the crutch, the point emerging 1 inch below the tuber ischi. The points should be shielded at once with cork to prevent injury to the hands of the operator. No vessels are endangered by these skewers. A mat or compress of sterile gauze 2 inches thick and 4 inches square is laid over the femoral artery and vein as they cross the brim of the pelvis, over this a piece of strong white rubber tubing,  $\frac{1}{2}$  inch in diameter when unstretched, and long enough when in position to go five or six times round the thigh, is now wound very tightly round and above the fixation needles and tied.\* By this means the limb can be removed with practically no loss of blood.

Formerly but one operation was utilized for the removal of the limb at the hip-joint, viz., by transfexion, the flaps being cut antero-posteriorly. The great advantage of this method was the rapidity with which it was executed, it has, however, been replaced by other plans, one of which should always be adopted.

Amputation by an *external racquet incision* (Fig. 499, right leg) has been recommended by many surgeons, especially Feneau-Jordan, Esmarch, and Lister, each of whom has advocated some slight modification. The surgeon should always stand to the outer side of the limb, whilst the pelvis of the patient rests at the extreme edge of the table. The essential features of this operation consist in a circular division of the structures down to the bone below the lesser trochanter, whilst the head of the bone is disarticulated and removed through the external vertical portion of the incision extending downwards from above the great trochanter, it matters little whether the vertical incision is made before or after the tissues in the thigh have been divided. Perhaps the simplest plan of carrying out this operation is as follows. A circular incision is made through the skin and subcutaneous tissues 5 or 6 inches below the great trochanter. These are dissected up for a few inches, and the muscles divided circularly down to the bone, which

\* Wyeth, *Annals of Surgery*, February, 1877

is at once sawn through. The external incision, 6 or 8 inches long, is then made, the tissues being freed from the anterior and posterior surfaces of the femur, and the rotator muscles divided along the borders of the great trochanter. The lower end of the fragment of the femur is then grasped by long forceps, and after forcibly flexing and rotating the bone inwards, the capsule of the joint is laid open on its posterior aspect. By everting the bone, the anterior part of the capsule can be reached and incised, and the attachment of the ilio-psoas muscle severed. The ligamentum teres is then divided by inserting the point of the knife into the acetabulum, and the head of the bone is thus set free. One great advantage of this operation is that the incisions are placed as far as possible from the risk of septic contamination from the genital organs and perineum.

To our minds, the best method of amputating at the hip-joint is by means of an

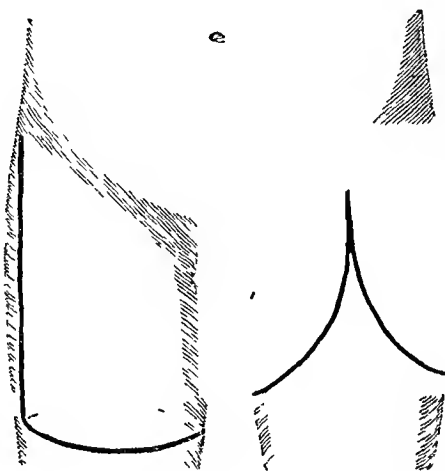


FIG 499.—AMPUTATION THROUGH THE HIP-JOINT

On the right leg Furneaux-Jordan's method is indicated, on the left leg the flaps required for the anterior flap operation are shown.

*anterior flap operation* (Fig 499, left leg). This commences over the centre of Poupart's ligament, and is carried down along the course of the main vessels for about 3 inches. The common femoral sheath is exposed, and both artery and vein are secured by double ligature and divided. The incision is then completed, it sweeps over the inner side of the thigh 4 or 5 inches below the perineum to the back, and is brought up again to the front 3 or 4 inches below the great trochanter. The muscular structures in the outer flap are then cut through, and the external circumflex artery and other bleeding vessels secured by pressure forceps *en route*. By rotating the limb inwards, the insertion of the gluteus maximus can be divided, as also the muscles attached to the great trochanter. The muscles in the inner flap are then similarly dealt with after rotating the limb outwards, the internal circumflex artery, etc., being secured. The capsular ligament is next divided transversely, and the head of the bone disarticulated. Finally, the limb is rotated forcibly outwards, and all the soft parts at the back of the limb, including the sciatic vessels and nerves, are divided from within outwards with one sweep of the knife. The wound when sutured lies antero-posteriorly.



## CHAPTER XLIV

### ANÆSTHESIA

THE practice of surgery has always been of such a nature as to render some means of abolishing the pain caused thereby a desideratum, but although in the old days various plans were adopted to attain this object, yet it was not until the end of the eighteenth century that any real advance was made in this direction. In 1799 Sir Humphry Davy suggested the possibility of using nitrous oxide gas as a means of rendering patients insensible during surgical work, but as then employed, it was so uncertain in its action that no great benefit was derived from the knowledge thus acquired, and many years elapsed before it came into extensive use. The demonstration of the properties of ether in 1846 by Morton, in Philadelphia, and of chloroform in January, 1847, by Sir James (then Professor) Simpson, heralded in a new era of surgery. Operations, which before were scanty in number, became greatly multiplied, and at the present day, with our advanced knowledge and experience, and our constant dependence on this agent, it is difficult to understand how surgical practice could have been conducted without it. Anæsthetics have enabled the surgeon confidently to attack almost every region of the body, and instead of operations being hurried over, in order to minimize the patient's sufferings, they are now undertaken with much more deliberation, accuracy being the great requisite at the present day, and not, as formerly, rapidity.

Anæsthetics may be divided into two groups—the local and the general.

**Local Anæsthesia** is utilized for the purpose of rendering parts insensible to pain, where slight operations of short duration are to be undertaken, or, occasionally, in more serious cases, where the patient cannot stand a general anæsthetic.

1. **Cocaine** is an alkaloid obtained from the dried leaves of the *Erythroxylon coca* (S America). The salt most commonly used is the hydrochlorate, which exists in the form of colourless needles, or a crystalline powder readily soluble in water. Its properties as a local anæsthetic were discovered by Koller of Vienna, and it was at the Ophthalmic Congress at Heidelberg in September, 1884, that its value in ophthalmic and surgical work was first publicly demonstrated.

Mucous membranes are readily anæsthetized by applying a 5 or 10 per cent solution to them for about five or ten minutes, the insensibility lasting for about the same time. In dealing with the skin or deeper tissues, hypodermic injections of the drug are relied on, the anæsthesia following the course of the peripheral nerves. The action of cocaine is supposed to depend partly on an anæmic condition of the affected tissues induced by arterial contraction, partly on paralysis of the terminations of the sensory nerves. Inflamed tissues are but little affected by it. When applied hypodermically the needle should be inserted in the line of incision, and the injection equally diffused along it. In making use of this reagent, it must always be remembered that cocaine has a distinctly depressing influence upon the heart, and hence more than  $\frac{1}{2}$  grain should never be employed. Should toxic effects be manifested (as by pallor of the face, a cold

clammy sweat, giddiness, weak and rapid pulse), the patient's head should be lowered, and stimulants administered. Some recommend that a little nitroglycerine (1 drop of a 1 per cent solution) should always be injected at the same time as the cocaine, so as to prevent contraction of the peripheral arterioles. In some parts of the body it may be possible to control the circulation so as to hinder the general absorption of the drug. Thus, for circumcision the base of the penis may be constricted by an elastic band, whilst a similar arrangement may be applied to the fingers and toes for small operations, such as avulsion of a toe-nail.

2 A substitute for cocaine has recently been proposed in the synthetic compound known as **Eucaine Hydrochloride**. Its toxic properties are much less marked than those of cocaine, and doses of even 5 or 10 grains may be employed either hypodermically or by painting over a mucous membrane. Its action is somewhat slower than that of cocaine, and it causes a little congestion of the part, whilst cocaine leads to anæmia, it also gives rise to a little tingling pain on injection, and may leave a certain amount of oedematous thickening for a time. The reports hitherto given have been very satisfactory, although, on account of the irritation produced, it does not seem to be quite so suitable for ophthalmic work.

**Schleich's Method** of inducing local anæsthesia consists in infiltrating the tissues of the part with a dilute solution of cocaine. This has been modified of late by the employment of eucaine and adrenalin, and Barker\* recommends the following formula

Distilled water	100 c c	= 3½ ounces
β-eucaine	0.2 gramme	= 3 grains
Sodium chloride	0.8 gramme	= 12 "
One pro mille adrenalin chloride solution		10 minims

There are no toxic effects associated with this solution, and a considerable quantity is employed in order to infiltrate the tissues. If allowed to act for thirty or forty minutes, the parts are often found to be not only anæsthetic, but also practically bloodless. Operations of gravity can be performed without pain, including such conditions as strangulated hernia, intestinal obstruction, tracheotomy, thyroidectomy, etc., when a general anæsthetic may be undesirable.

3 Local anæsthesia is also produced by **freezing** the part, either by the application of ice and salt, or by the ether spray, or with ethyl chloride. The latter reagent is now put up conveniently in small glass or thin metal flasks with a fine capillary outlet, on holding the flask in the hand a spray is produced, which is allowed to play upon the part to be operated on. The rapid evaporation from the surface leads to the freezing of the skin, which becomes of a dead white colour. The anæsthesia produced is of a very fugitive nature, and a certain amount of pain may be associated with the thawing process, but less than that caused by the ether spray.

**General Anæsthesia**—1 **Nitrous Oxide Gas** ( $N_2O$ ) is most commonly used in dental work, or for short operations, such as bending a stiff joint and breaking down adhesions, the avulsion of a toe-nail, or the opening of an abscess. It is practically safe and not unpleasant, either in its use or in its subsequent effects. It is also employed in conjunction with ether, the patient being first anæsthetized with gas, and the condition maintained by ether. Gas has also been recommended for the removal of adenoids, but the general opinion now obtaining is that, to perform this operation satisfactorily, a more lasting anæsthetic is required. The gas is stored in a condensed and liquefied form in special steel cylinders, closed by a screw which can be readily loosened, so as to allow the gas to escape through a tube into an india-rubber bag. This is attached to a closely-fitting face-piece, with a suitable arrangement of valves and stop-cocks, by means of which the gas is allowed to reach the patient. A valvular exit for the expired air is also present (Fig. 500). In its usual method of administration the bag is first filled with gas, and then air is completely excluded by carefully adjusting the padded face-piece to the irregularities of the face. Some anæsthetists, however, by means

\* *Brit Med Journ*, December 24, 1904, p. 1683

of a special apparatus devised by Dr Hewitt, allow the administration of a minute proportion of pure oxygen at the same time, in order to prevent the lividity of the face and the twitching of the limbs often present when anaesthesia is induced in the ordinary way. These symptoms of incipient asphyxia may also be avoided by allowing the last few inspirations of the gas to be mixed with an



FIG 500—APPARATUS FOR THE ADMINISTRATION OF NITROUS OXIDE AND ETHER IN COMBINATION

A, Steel cylinders containing compressed nitrous oxide, B, indiarubber bag, C, three-way stop-cock with valves, D, Clover's ether chamber, E, face-piece. If nitrous oxide alone is administered, D is omitted. When ether alone is used, A and C are omitted, and a smaller bag substituted for B.

This may be done by raising the face-piece, by opening the air valve, or as suggested by Dr Flux, by using an open inhaler into which the gas is poured. Of course, in removing teeth the mouth is firmly gagged open prior to the commencement of the administration.

2 **Chloroform** is perhaps the anæsthetic most generally employed, on account

of the ease with which it can be administered, although there can be but little doubt that its use is attended with somewhat more risk than that of ether. Much controversy has arisen as to whether the heart is ever directly affected by the drug, or whether the dangerous symptoms met with are not due to primary failure of the respiration. The experimental evidence on the subject is of a very conflicting nature, and it is impossible as yet to consider the question solved. The Scotch school of surgeons, headed by Syne and Lister, has always maintained that the breathing alone need be watched during the administration of chloroform, failure of the respiration being the first danger signal, the second so-called Hyderabad Commission has sought to confirm this view. Many practical surgeons and anesthetists oppose this statement, holding that, although the respiration may fail first in a large percentage, and probably a majority, of fatal cases, yet there are a certain number in which heart failure is also seen as a result of the direct toxic effect of the chloroform upon its muscular substance. Certainly, in not a few instances of death during the administration of chloroform the heart stops first, but a great distinction must be drawn between the deaths which result from chloroform, and the deaths that occur during the administration of chloroform. An overdose of chloroform, without doubt, leads to failure of the respirations, but in the majority of such cases, if suitable precautions are adopted sufficiently early, a fatal result may be averted. Cases in which the heart stops first are probably due to syncope, and are not entirely dependent on the nature of the anæsthetic administered.

Chloroform may be given in several different ways, but in all the chief points to be attended to are regularity of dose, and full admixture with air, so that not more than 4 per cent of the vapour is inspired. The plan so often employed of pouring an unknown quantity of chloroform on a piece of lint, folded in two or three layers and held close to the patient's nose and mouth, is most unscientific and to be strongly condemned. The *Open Method* is that recommended by Lord Lister. A mask reaching from the root of the nose to the chin is made from the side of a towel, and fixed with a safety-pin. This is first held some inches above the patient's nose, and moistened from the outside with chloroform from a drop-bottle. As the respiratory passages become tolerant of the drug, the mask is gradually lowered to touch the face, and is kept continually moistened. At the end of two or three minutes the respirations increase in frequency, and a stage of excitement may be reached, during which the patient may sing, shout, or struggle violently. The anæsthetic is still cautiously pushed, care being taken that during the deep respirations which follow the struggling stage an overdose is not administered. Complete anæsthesia is indicated by relaxation of the muscles, loss of the corneal reflex, and contraction of the pupil, and it is usually attained in about five minutes. As long as the operation lasts, the anesthetist must endeavour to maintain this condition, but the amount needed during the later stages is much less than at its commencement.

*Funk's inhaler* is often used for giving chloroform, especially in operations about the nose and face. It is economical, and on the whole satisfactory. In this apparatus air is pumped through a layer of chloroform to an inhaler placed over the patient's mouth, or to a tube passed into his nose. The air laden with chloroform is inspired, and produces the usual constitutional effects, the amount administered is, to a certain extent, regulated by the rapidity with which the india-rubber bulb of the apparatus is squeezed, after a time, however, the lowered temperature induced by the evaporation leads to a diminution in the amount of chloroform vapour given off. Accidents have happened with this apparatus from filling the bottle too full, or from having the india-rubber tubes fixed to the wrong nozzles, in either instance liquid chloroform may be pumped out of the exit-tube.

3. **Ether** is generally considered to be a safer anæsthetic than chloroform, in that it is a cardiac stimulant. It is usually administered by Clover's apparatus or by Simsby's mask. *Clover's apparatus* (Fig 500, D and E) consists of a face piece similar to that utilized for giving nitrous oxide, a metal receptacle for the ether, and a bag. In this apparatus the air used in respiration passes over the surface of the ether contained in the receptacle, the proportion of ether inspired being regulated, so that

at first a considerable admixture of air is permitted, whilst later on ether vapour in the proportion of a third, a half, or even two thirds, is inhaled. The chief advantage of this apparatus is the ease with which the amount of ether administered is regulated, but a distinct disadvantage exists in the fact that the patient breathes his own expired air again and again, and so, unless care is taken, he is likely to become cyanosed. This can, however, be prevented by removing the mask occasionally, and giving the patient a few breaths of unmixed air. Another objection lies in the amount of mucus which often collects about the pharynx, whilst the moisture in the expired air condenses in the bag, which becomes very objectionable unless carefully washed out after each administration.

In *Ormsby's mask* the ether is poured over a sponge which is contained in a wire frame prolonged from the face-piece, and covered over by a bag into which the patient breathes. It is an unpleasant means of inducing inæsthesia, but may be employed for maintaining it after the use of gas. The same objections hold good as in Clover's apparatus, and the same precautions as to letting in atmospheric air from time to time must be observed.

In the administration of ether it is now usual to adopt what is known as the 'gas and ether method,' by which is meant that the patient is first æsthetised with nitrous oxide, and the anæsthesia is continued and maintained by means of ether. If the Clover's inhaler is to be employed, the arrangement shown in Fig. 500 is employed, a Clover's ether-chamber being interposed between the face-piece and the three-way tube of a nitrous oxide apparatus. The patient is first allowed some six or eight full inspirations of nitrous oxide gas, and then the ether-chamber is turned to permit of gradually increasing doses of ether vapour. As soon as symptoms of nitrous oxide inæsthesia present (twitching of muscles, irregular stertor, etc.), the gas-bag is detached and the ordinary ether-bag substituted.

The Ormsby's mask does not permit of this gradual addition of ether vapour, full nitrous oxide anæsthesia must be induced with the ordinary apparatus, and then a rapid change is made to the fully-charged ether inhaler. The results are sufficiently satisfactory, but much more experience and skill are required than when the Clover apparatus is used.

The advantages claimed for this 'combined method' are that anæsthesia is induced much more rapidly (two minutes), and, what is far more important, the process is much less unpleasant for the patient than when ether alone is employed. The patient is apt, especially when the Ormsby's mask is used, to become rather livid and rigid, but these conditions pass off in the course of a minute or two.

4 To obviate the depressing effects of chloroform, a combination known as the **A C E Mixture** is often used consisting of alcohol, chloroform, and ether, blended in the proportion of one, two and three parts respectively. It may be given either from a Rendel's mask, or by the open method as for chloroform, but the latter plan is only applicable to children and weakly individuals, who require but little anæsthetic. *Rendel's mask* consists of an oval box open at one end and shaped to fit the nose and mouth, and the fundus perforated with holes to permit of the free entrance of air; it may be made of leather, or preferably of celluloid or metal. Two or three sponges are placed within it, and soaked with the anæsthetic, the patient breathing in and out of the cone. The inspired air is thus laden with the vapour, and the amount admitted is regulated in measure by covering a certain proportion of the inlet holes with the hand. The objection to this reagent is that it evaporates somewhat unequally, the ether coming off first, and leaving an excess of chloroform, which when administered in a cone may be dangerous, this can, however, be obviated by remoistening the sponges alternately with the mixture and with pure ether.

5 During recent years **ethyl chloride** has been introduced as a general anæsthetic with excellent results. It may be used (a) for short operations on the mouth or nose—e.g., tooth extraction or removal of adenoids, where a single dose is sufficient for the purpose, (b) for minor operations elsewhere—e.g., opening abscesses, reducing fractures and dislocations, and (c) for inducing anæsthesia, which can be maintained by ether, in prolonged operations. Its utility is limited by its extremely volatile nature and by the method which must

be employed in its administration. For this purpose an Oimsby's mask is utilized, 2 or 3 cc are poured on the sponge, and the apparatus is firmly placed over the patient's mouth. Anæsthesia is quickly induced without struggling or suffocative effects, and after the operation is over the patient rapidly regains consciousness, and rarely suffers from unpleasant after-effects. A combination of this agent, known as **Somnoform**, has been a good deal exploited, but there is no advantage in its employment, it is probably less pleasant to take, and leaves more marked after-effects.

### General Remarks as to the Administration of Anæsthetics

The medical practitioner must never lose sight of the fact that a certain element of risk is necessarily attached to the artificial induction of a condition in which the activity of the nervous system is entirely suspended, except for the maintenance of those phenomena which are actually essential for life. Hence, an anæsthetic should never be given, unless absolutely necessary, without careful preparation of the patient, or such examination as shall satisfy the doctor as to his capability of safely taking it.

The **Preparation of the Patient** is a most important proceeding. When practicable, the general habits of the individual should be carefully regulated for a few days prior to the operation, and on the preceding night a suitable purgative is administered, castor-oil being perhaps the most efficacious. Any food given on the morning of the operation should be light and easily assimilable, whilst nothing should be taken for at least three hours previously, so as to make sure that the stomach is empty. In casualty cases, it may be advisable to relieve gastric distension with an emetic, or by washing out the organ before commencing the administration. The anæsthetist must ascertain that no loose artificial teeth are present in the mouth, and that no tight clothes or bands encircle the neck or thorax. In very nervous cases, or where much shock is anticipated, a preliminary hypodermic injection of strychnine or a nutrient enema may be administered.

The anæsthetic should never be pushed in the early stages, but is given slowly and gradually, especially in nervous individuals. When there is any struggling, the movements of the limbs should be restrained with as little force as possible, and care must be taken during the deep respirations which follow such struggling not to administer an overdose. The condition which the administrator should aim at maintaining is one characterized by total muscular relaxation, insensitiveness of the cornea, and a contracted state of the pupil, whilst the pulse and breathing continue regular. If the pupil commences to dilate, and the corneal reflex is present, the patient is apt to move when the knife is used, indicating that more anæsthetic is required. Dilatation of the pupil with an insensitive cornea is always an indication for suspending the administration for a time. If the anæsthesia is not sufficiently deep, vomiting is likely to occur, being ushered in by weakness and rapidity of the pulse, and pallor of the face, this may often be averted by pushing the anæsthetic. The anæsthetist's chief attention must be directed to observing the state of the respiration and pupil, but he should also note the colour of the lips, cheeks, and ears, as thereby valuable information is gained as to the condition of the circulation. The pulse should be felt occasionally, but it is less important to attend to this than to the other points noted above. After the deep anæsthesia required in division of the skin, most operative proceedings on the subcutaneous tissues are comparatively painless, and hence the anæsthetic need not be pushed quite so far. Whilst the wound is being closed, the patient must be kept somewhat more completely under control. In operations upon the mouth associated with hæmorrhage the head must be occasionally turned to one side to allow the blood to gravitate out of the mouth, and the pharynx well sponged, so as to prevent the admission of clot and other matters into the air-passages. It is also a valuable routine plan to moisten upon the head always being turned on one side especially when ether is being given, since mucus tends to collect about the pharynx.

The **After-Treatment** of the patient is always a matter of considerable im-

portance. He is carried from the table and placed on his back, or preferably, when possible, on his right side, in bed with the head low. When there is any tendency to shock, hot-water bottles, well wrapped up, should be applied to the feet and sides, and hot blankets over all. Absolute quiet must be enjoined for some hours, and the room darkened, so that, if possible, the patient may fall asleep. No food is administered for at least three or four hours, and then only very cautiously, a little weak tea, soda-water, or beef-tea being given. The patient is likely to vomit on returning from unconsciousness, perhaps bringing up a little bile-stained mucus, but if the anæsthetic has been judiciously given, it soon ceases. Occasionally, however, the vomiting persists for some time, becoming very troublesome. It may generally be checked by a hypodermic injection of morphia, and by washing out the mouth with warm water, but in more severe cases, lasting for some days, the patient's nutrition may have to be maintained by enemata, and the stomach kept absolutely at rest. Benefit may sometimes be derived by giving a little bismuth and hydrocyanic acid in an effervescing mixture, or perhaps champagne, but, as a rule, all administration of food by the mouth should be stopped until the vomiting has ceased.

Three chief Dangers are encountered during the administration of anæsthetics.

1. **Obstructed Respiration** usually results from falling backwards of the root of the tongue, which blocks the entrance of air into the larynx. The respirations gradually become more and more stertorous, the face and ears become dusky, and, if the condition is not relieved, the chest continues to heave without any air entering or leaving it, and finally ceases when the patient is completely asphyxiated. The early stages of this condition are of common occurrence, whatever the anæsthetic, and the administrator must always be on the look-out and endeavour to prevent it by turning the head on the patient himself so that the tongue falls to one side. If it occurs in spite of this position being adopted, the administration is at once suspended, whilst the tongue must at all hazards be drawn forwards. This may be accomplished in the early stages by pulling on the beard or chin, or by pressing the mandible forwards by the fingers placed behind the angle of the jaw. In the later stages the mouth should be forcibly opened by a gag, and the tongue grasped by forceps and pulled well forwards, or a finger may be passed back into the pharynx to draw the root and epiglottis forwards, and at the same time ascertain that the entrance to the glottis is free from obstruction. Artificial respiration should be undertaken if the breathing has actually stopped. Death should never result from this cause, and if it occurs, it can only be attributed to the carelessness of the anæsthetist.

Obstruction to the respiration may occasionally arise from the entrance of vomited material into the air-passages or lungs, the patient becoming cyanosed during an attack of vomiting, and passing rapidly into a state of asphyxia. In such a case the finger must be swept around the pharynx, if the mouth can be opened, to see that the glottis is clear, whilst tracheotomy or laryngotomy may be necessary should the teeth be firmly clenched, or if the obstruction is below the entrance to the glottis. Fortunately, this accident is of rare occurrence.

2. **Complete Cessation of Respiration** is the usual primary phenomenon from an overdose of chloroform, it is also stated to happen occasionally during ether narcosis. The pulse continues to beat distinctly for a few seconds, although respiratory movements have ceased. Treatment consists in at once stopping the administration, whilst the tongue is drawn forwards, and the fauces cleared by the finger. The head should be lowered over the end of the table, and young children may even be completely inverted, so as to induce a flow of blood to the head. Artificial respiration is commenced without delay, whilst the thoracic parietes may be flicked with a cold wet towel, or alternately douched with hot and cold water. Strychnine or ether should also be injected hypodermically, and if the condition persists and the heart's action ceases, a Faradic current may be passed from the second or third intercostal space in front to an electrode placed over the spine. Attempts at resuscitation should be continued for half to three-quarters of an hour. At the same time, these measures must be undertaken with discretion, as otherwise it is quite possible to extinguish the feeble spark of life by the very means which, used wisely, would have restored it.

3. Death occasionally results from primary Cardiac Failure, which may arise

(a) from fright during the administration of the anæsthetic, (b) from shock with cardiac inhibition, by commencing the operation before complete anæsthesia has been obtained, and (c) from an overdose of chloroform or ether acting directly on the nerve centres or on the muscular substance of the heart. On *post-mortem* examination in such cases, the heart muscle is found to be thin and flabby, and perhaps infiltrated with fat, the ventricular walls are especially affected. Unfortunately, this condition cannot be recognised with certainty by the stethoscope. Patients with simple valvular lesions, where the defect has been more or less compensated, do not generally run any extra risk. The treatment to be adopted in cases of cardiac failure during anæsthesia is the same as for stoppage of the respiration.

The **Choice of an Anæsthetic** in any particular case depends mainly on the condition of the circulatory and respiratory apparatus of the patient. Ether is perhaps, on the whole, the safest agent to employ, especially in adults, although it is less pleasant to take, it may cause a good deal of bronchial irritation and congestion, and is more likely to give rise to troublesome after-vomiting, although such does not usually last long. It is sometimes followed by unpleasant delirium. Chloroform is easier to administer, more pleasant to take, and less likely to lead to objectionable after-effects. It is the best anæsthetic for young children and old people, though its action upon the heart contra-indicates its use in patients whose circulation is weak. The A C E mixture may also be safely employed, if the precautions already indicated on an earlier page are attended to.

Ether is certainly contra-indicated in patients suffering from any bronchitic or pulmonary trouble, and its administration for operations about the face or mouth is, of course, impracticable. Chloroform should not be given in cases of cardiac weakness or advanced renal disease, for abdominal work it is always to be preferred to any other agent, as also in operations on the brain.





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